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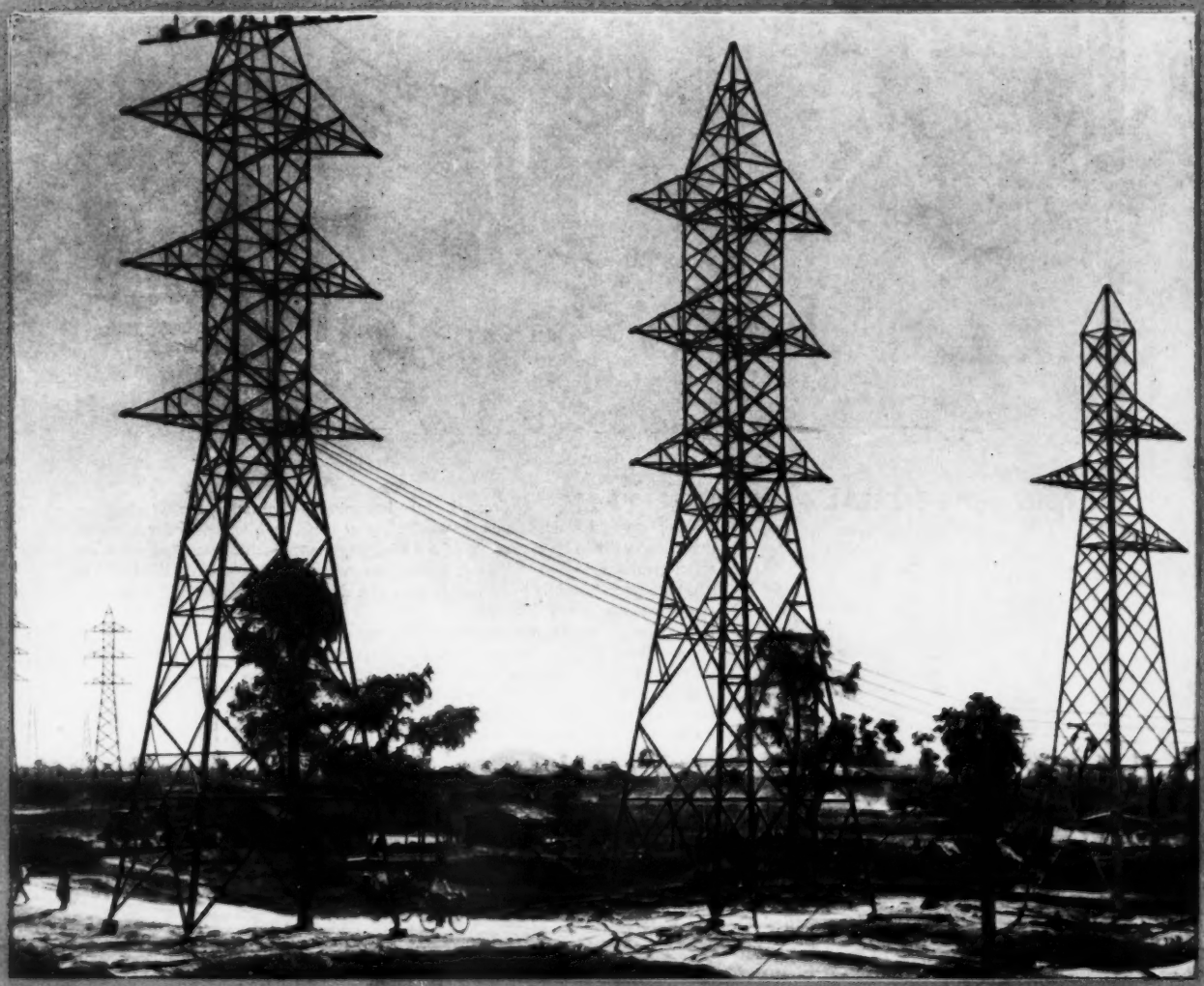
VOL. V. NO. 12 DECEMBER 1955 RUPEES TWO



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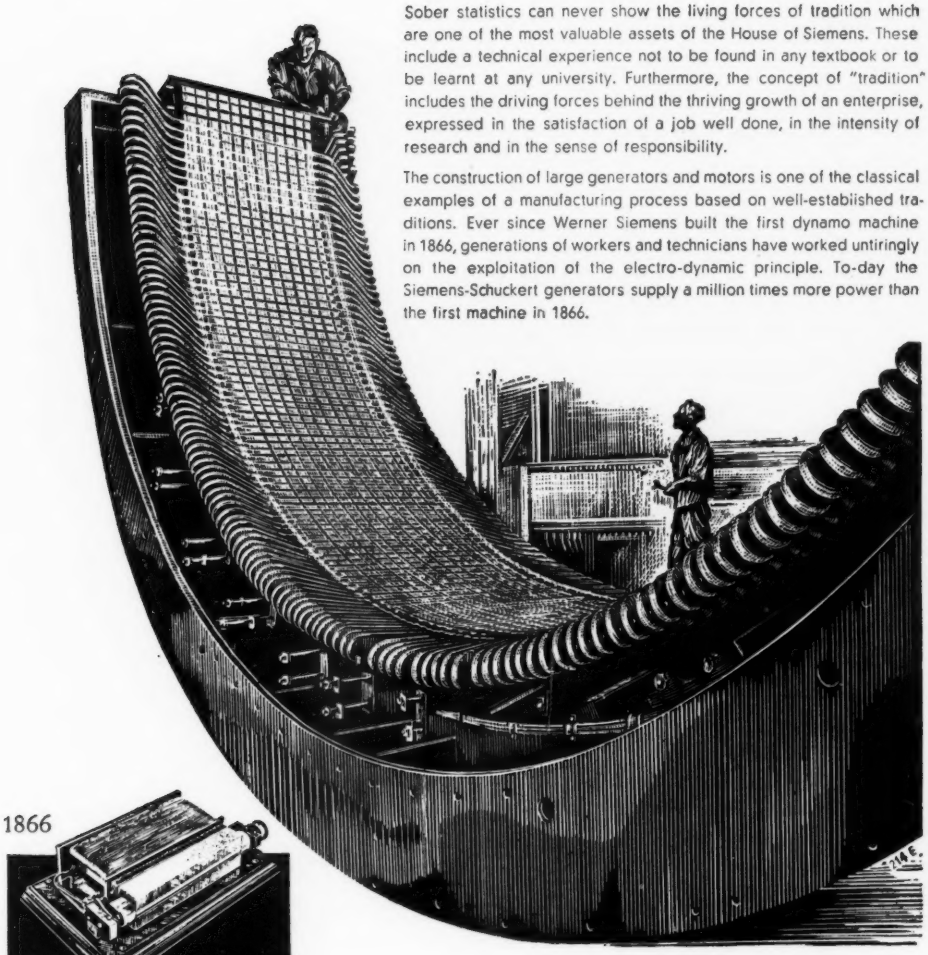
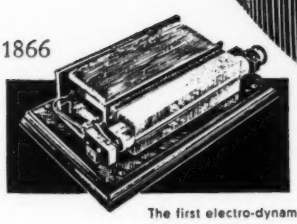


1866



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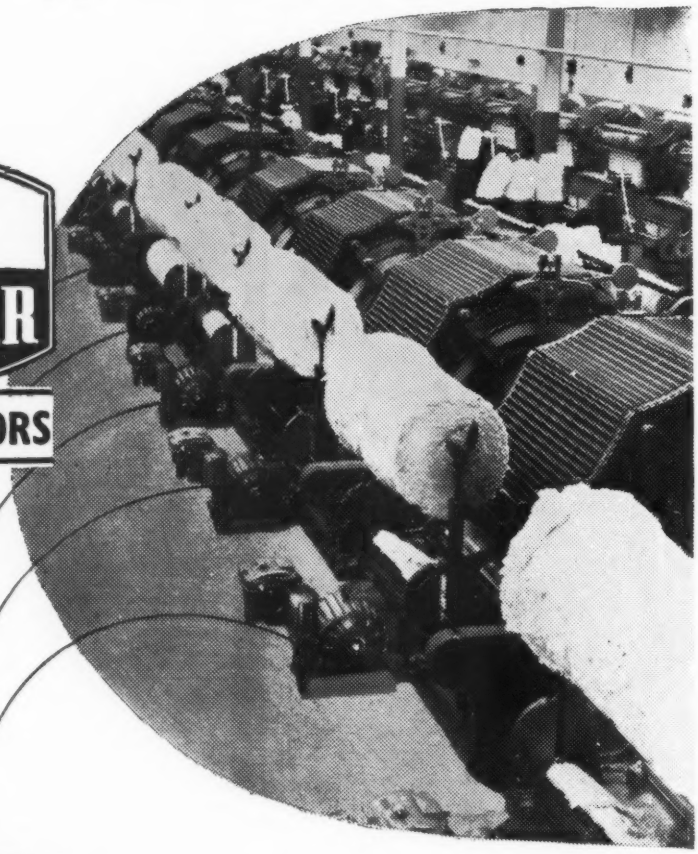

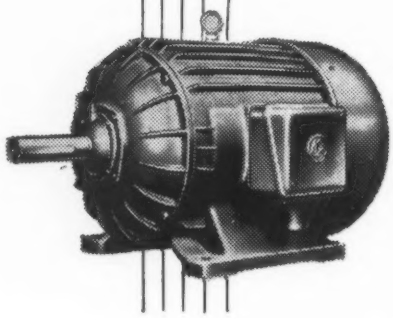

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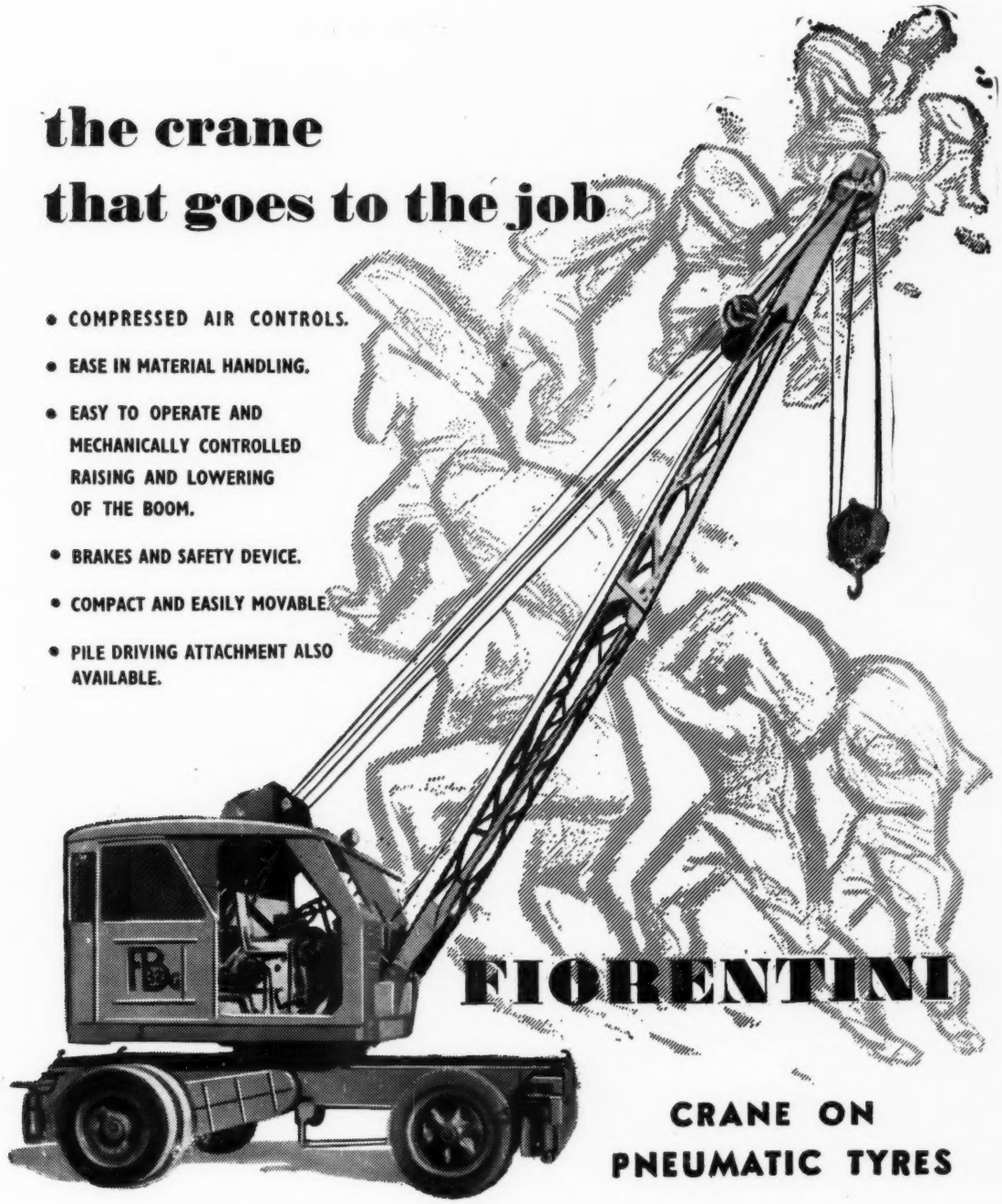

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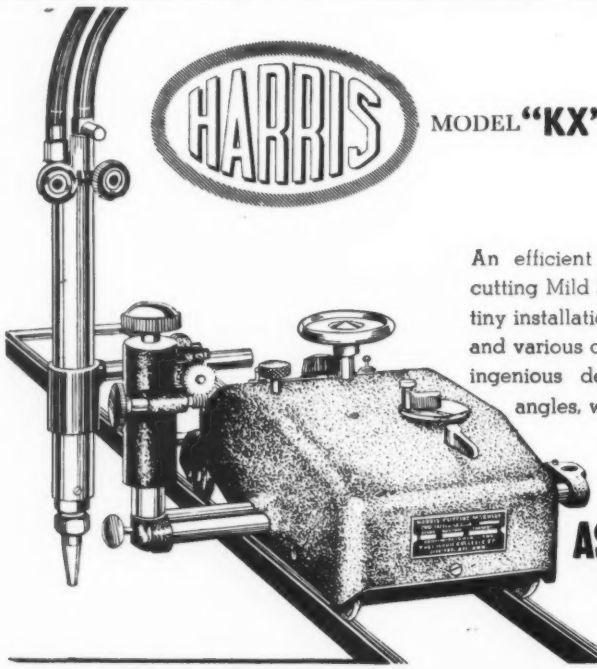

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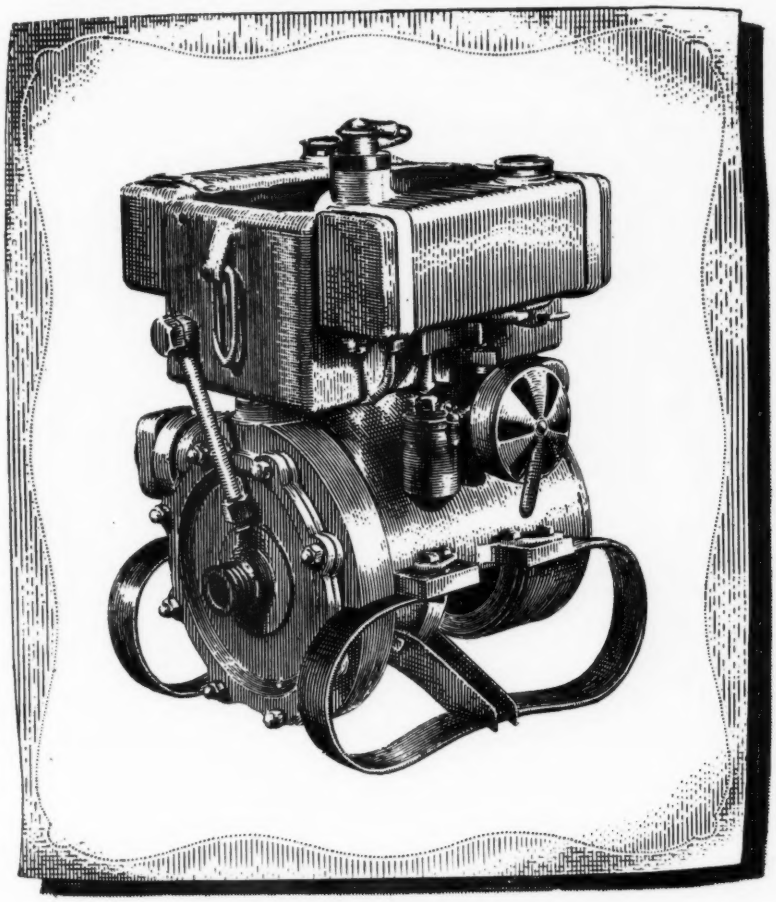

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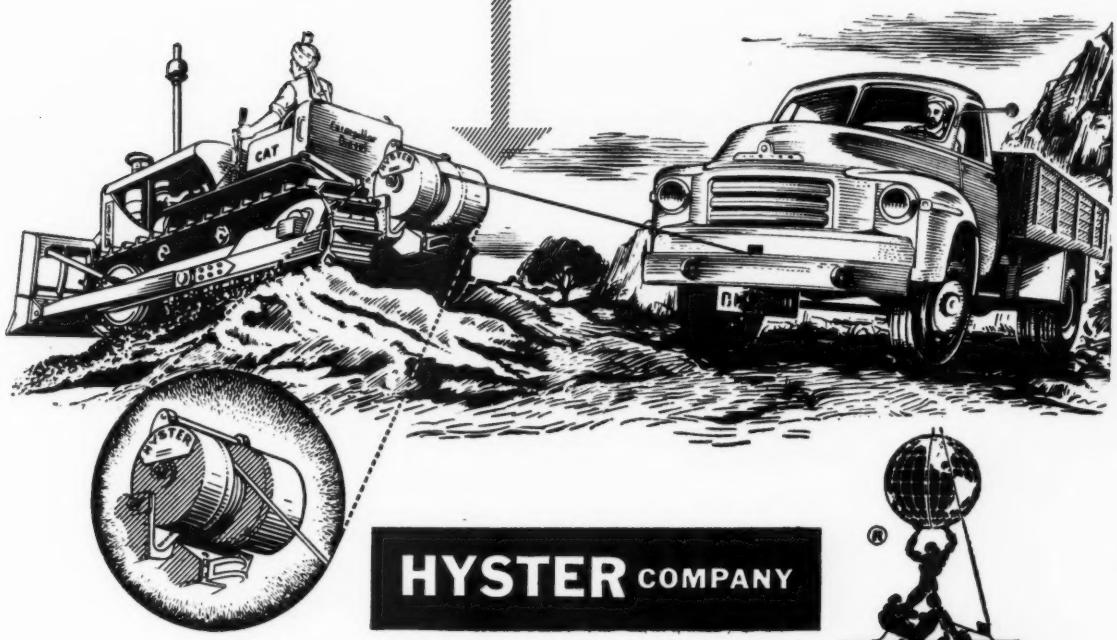

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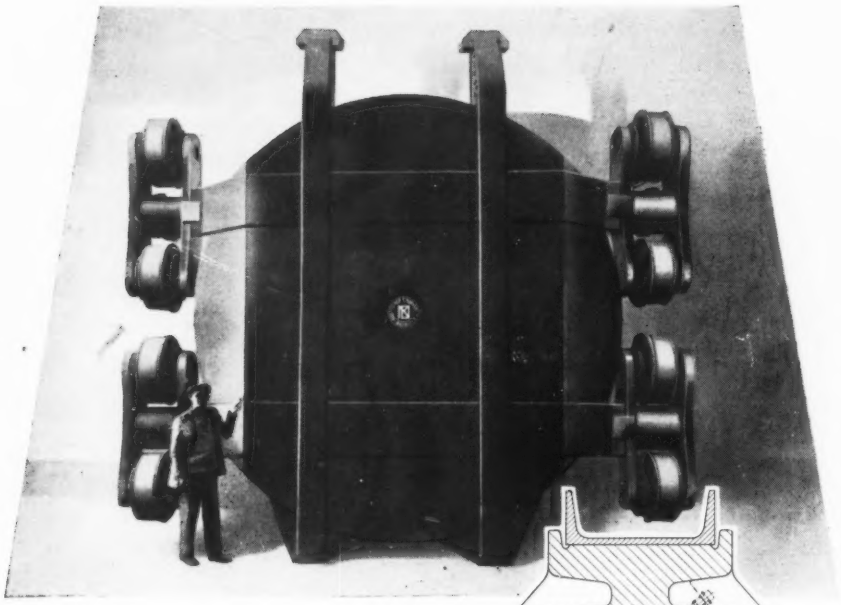

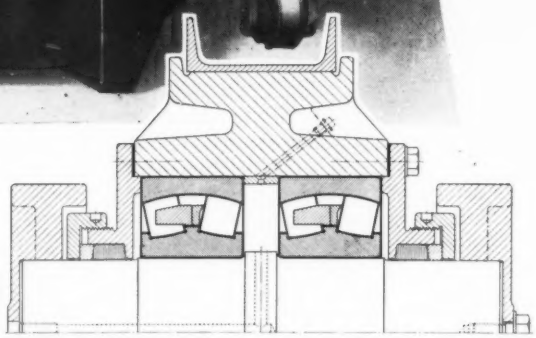

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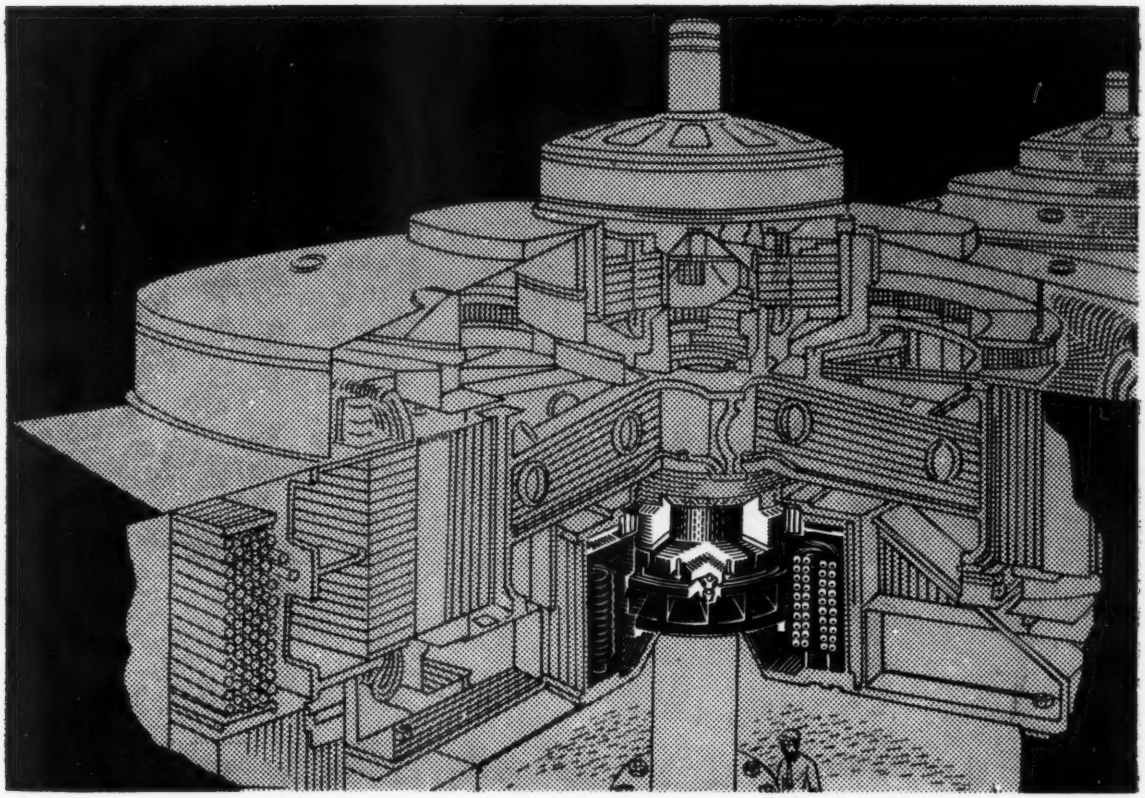

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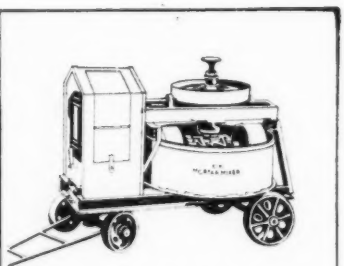

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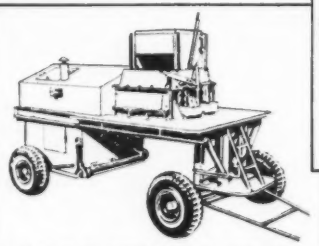

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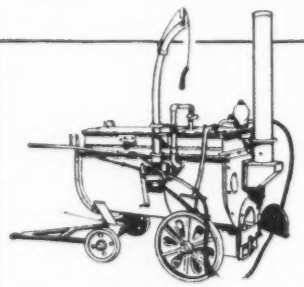

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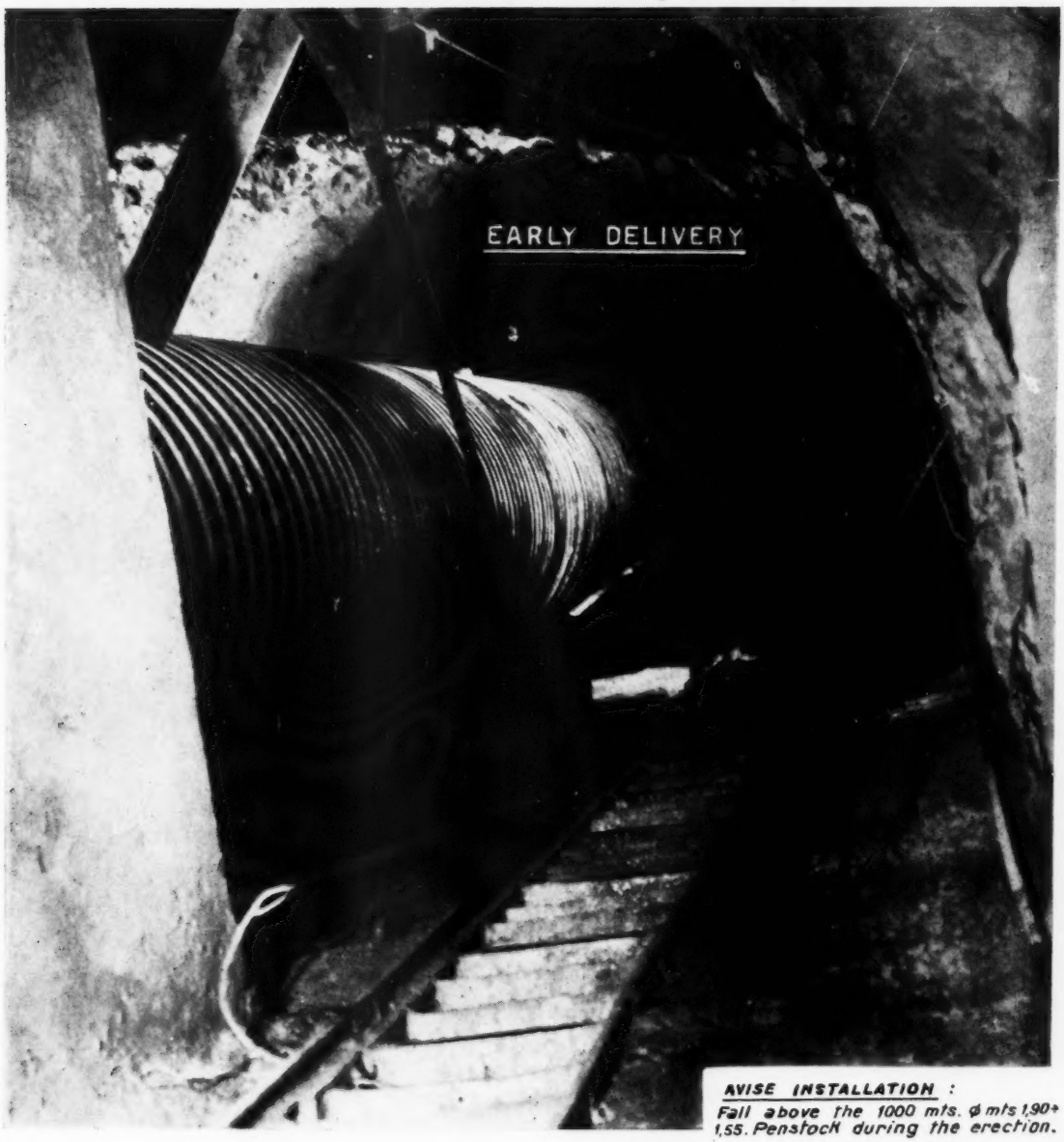

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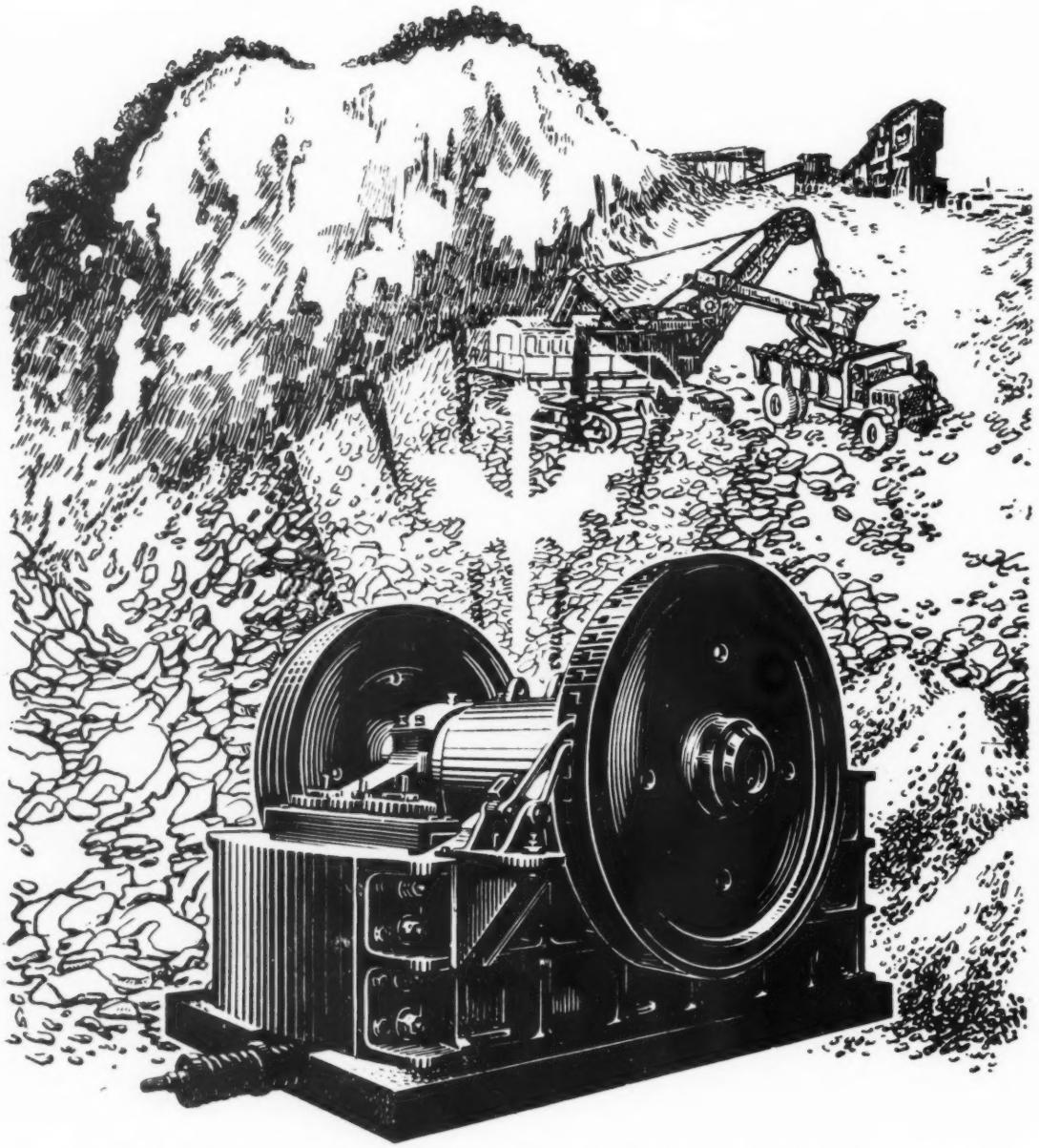

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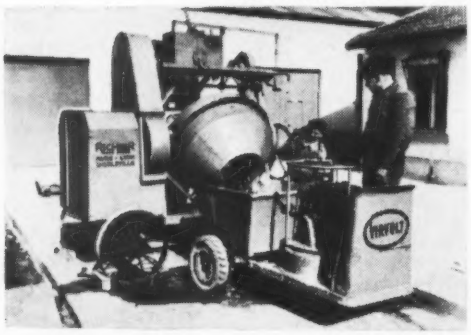

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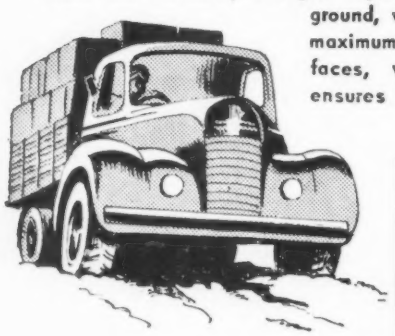

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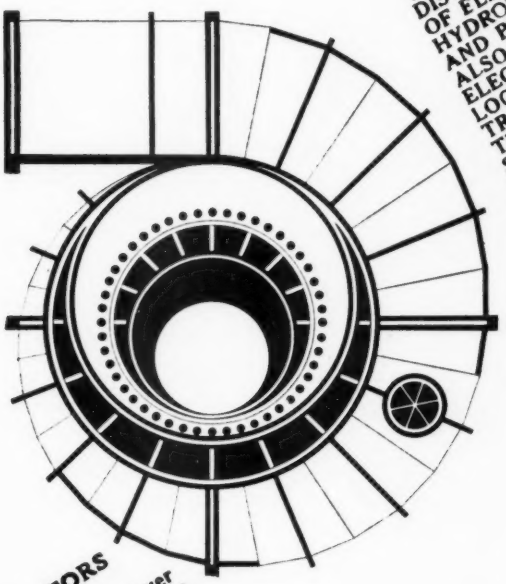

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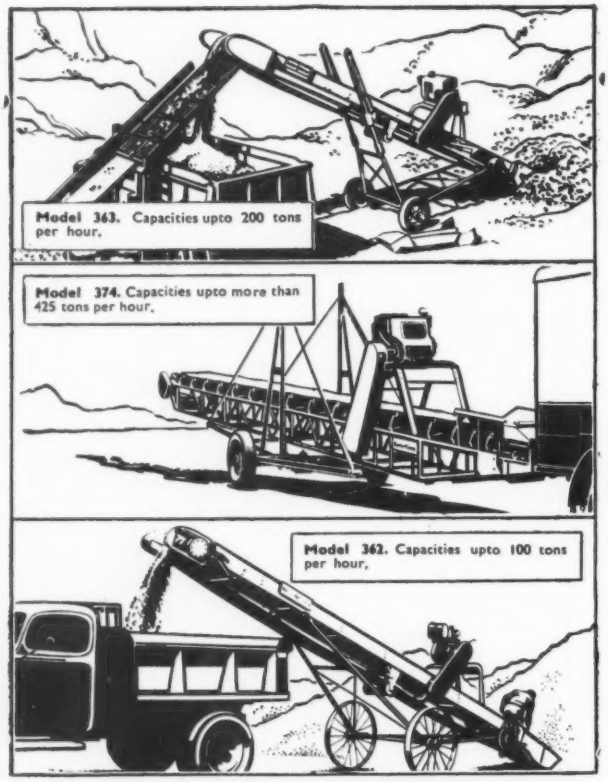
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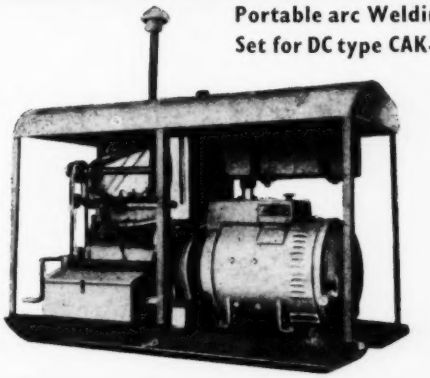

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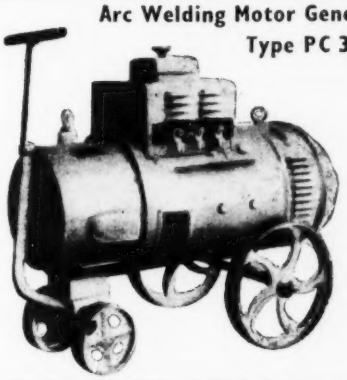

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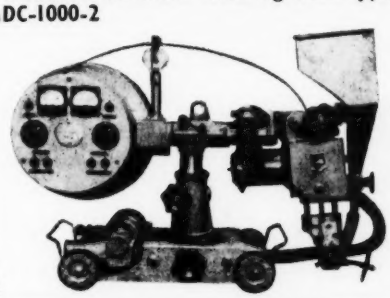

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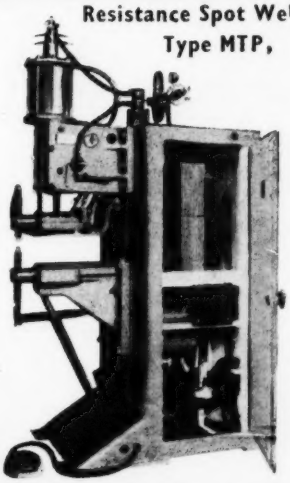

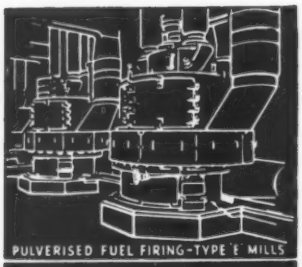
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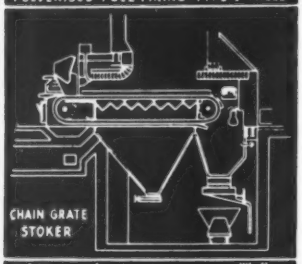
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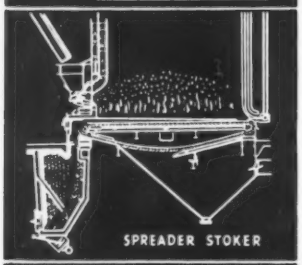
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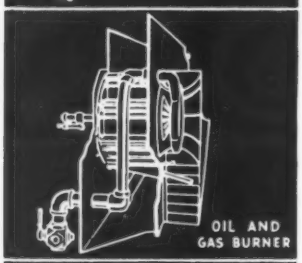
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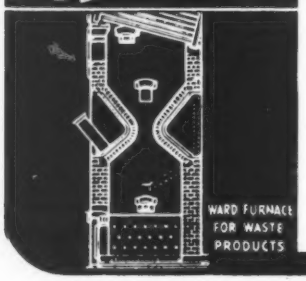
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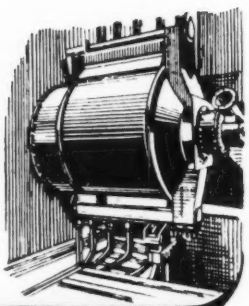
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The Future of Atomic Energy

JOHN COCKROFT

AUTHOR

The UNO Conference on Atomic Energy held in August this year was a memorable event in the history of science as well as of mankind. Its echoes and reverberations will be felt in all parts of the world for generations to come. We publish below the concluding speech of Sir John Cockroft delivered in that Conference on August 19th.

The speech by the eminent Director of Atomic Research in Britain and one of the World's best minds on the subject admirably surveys the possibilities of the use of Atomic Energy in various parts of the world in relation to the fuel position of each country from other conventional sources. For some, atomic energy is going to be an important source in the immediate future (like Britain) and for others it is to be only an additional source. The author has briefly assessed India's position in this context. The role of "packaged reactors" in arid areas far off from fossil fuels is worthy of attention.

We strongly commend the study of this speech to every educated man, in order to have a bird's eye-view of the wide perspective opened up by the release of atomic energy by man's creative endeavour.

To many of us this Conference has been a celebration of a very great achievement of the scientific world—the harnessing of the energy of atomic nuclei to serve the future needs of man. This is the culmination of scientific work of men of genius in many nations. It is fitting therefore that representatives of the great majority of countries should have come together or present their contributions to this work and to discuss how this new source of power can help the future development of their countries and the whole human race.

We have had described to us the first experimental atomic power stations and have heard that they are working well. We have also heard of the rapid progress of construction of the first full scale nuclear power stations. Within two years they will be delivering very substantial amounts of electricity to industry and we will begin to gain experience in their operation and economics. These early stations will be closely followed by successors of different and generally improved designs, so that within five years we are likely to have at least ten nuclear power stations generating up to 200 megawatts in a single unit operating in different parts of the world.

These will all be pioneering or demonstration stations built to test the technology on which all depends and to compare the relative advanatges of the ten most promising types both from the point of view of economics and also of reliability and safety in operation. So most of the next decade will be occupied in laying a sound basis from which nuclear power can expand rapidly to become in the end the major power source of the world. Until we have achieved satisfactory operating experience we will not be justified in embarking on a more rapid expansion.

This new industrial development has the advantage of a very great and unparalleled concentration of sicientific and engineering ability driving it forward with imagination and enthusiam—as you can judge from the papers which have been presented to this Conference. So the speed of development will be rapid and the nuclear power stations of 1970 will look as different from those of 1957 as the modern motor car differs from the Model T Ford.

The papers presented to the Conference have shown that we must not expect the cost of nuclear power to be cheaper in the next decade than power from coal. The consensus of opinion is that capital costs will be appreciably higher—50 to 100 per cent higher—than the capital costs of coal stations, but that fuel costs will be less than half that for coal. So on balance there should be little difference in the cost of power, with nuclear power slightly more expensive than conventional power.

But to many countries this is not the *important* point. The important point is to obtain an *additional* source of energy to our conventional energy resources where they are becoming overstrained.

Nevertheless the whole history of engineering development shows how rapidly capital costs fall in the early stages of important new developments, and there is good reason to believe that in the second decade the cost of nuclear power will fall below that of power from coal and oil.

Our second major objective is progressively to increase the amount of energy we can extract from each ton of uranium and thorium. We believe, although we have not yet proved the point, that in the early stations we can extract from one ton of uranium the heat equivalent of about 10,000 tons of coal in a single fuel cycle ; but we have also heard of the promise of recycling the fuel in thermal reactors several times so that the energy extraction can be increased 5 or 10 fold. We have also heard of the more ambitious *final* goal of achieving the nuclear physicist's dream of making use of the breeding principle, and so, extracting a great part of the fission energy of the whole uranium. In this way we expect to make

Sir John Cockroft *is the Director of Atomic Research at Harwell, Great Britain.*

one ton of uranium do the work of at least a million tons of coal. The engineer has still to convert the physicist's dream into large scale practical power stations but we have heard during the Conference of the building of large scale experimental breeder reactors both of the homogeneous and fast reactor types. Both have their difficult engineering problems but sometime during the second decade breeding is likely to be an important characteristic of nuclear power stations.

Our economists and statisticians have looked ahead to the years 1975 and 2000 and they have predicted that by these years our energy requirements will increase by at least 1½ times in 1975 and by 3 times in the year 2000. So by the end of the century the world is likely to require the energy equivalent of 7 or 8 milliard tons of coal a year as compared with our present usage of 1.7 milliard tons a year. (By milliard I mean 10^9). Almost one half of this energy will be required for generating electricity. Hydro-electricity should by then be fully developed, but even so will only do the work of I milliard tons of coal a year. It will be a great help to the human race if by the year 200 nuclear energy can generate the remainder of the electricity and so do the work of two to three millard tons of coal a year.

We have heard the forecast of uranium supplies—how it occurs throughout the world, not only in concentrated deposits but in abundant gold ores, shales, phosphate rocks. In seven countries alone there is reported to be available at least one million tons of uranium, whilst costs of uranium toward the end of the next decade have been predicted to be as low as 10 dollars a pound. The evidence presented to this conference suggests that in the 1960's there will be more than enough uranium for the nuclear power development of that decade. If we look further ahead and combine the forecast of nuclear energy produced in the year 2000 with the forecast of the achievement of breeding, we can see at once that only a few thousand tons of uranium or thorium a year would be required for this task. So there would appear to be ample uranium and thorium available to accept the economists' predicted task and if necessary to do even more than this, carrying a still greater share of the world's energy needs until we achieve our final goal and produce by fusion reactions in the *light* elements an inexhaustible power source for the world.

If we look into the middle distance—the 1970's—the use of nuclear power is likely to vary greatly from nation to nation. Some countries such as Norway, blessed by abundant and cheap hydro-electric power, will still be developing these resources as their primary source of energy. Many other nations such as France, Italy, Portugal and Sweden with important hydro-electric development still to come, will by then have completed this development and will be turning to nuclear power.

Great Britain

Great Britain is an example of a highly industrialised country with small hydro-electric resources, with poor prospects of any substantial increase in coal production and with a rapidly increasing demand for electricity and other forms of energy. So *early* nuclear power development is essential for Britain—it comes only just in time for us—and we believe that by 1975 almost half our electricity will be developed from nuclear energy.

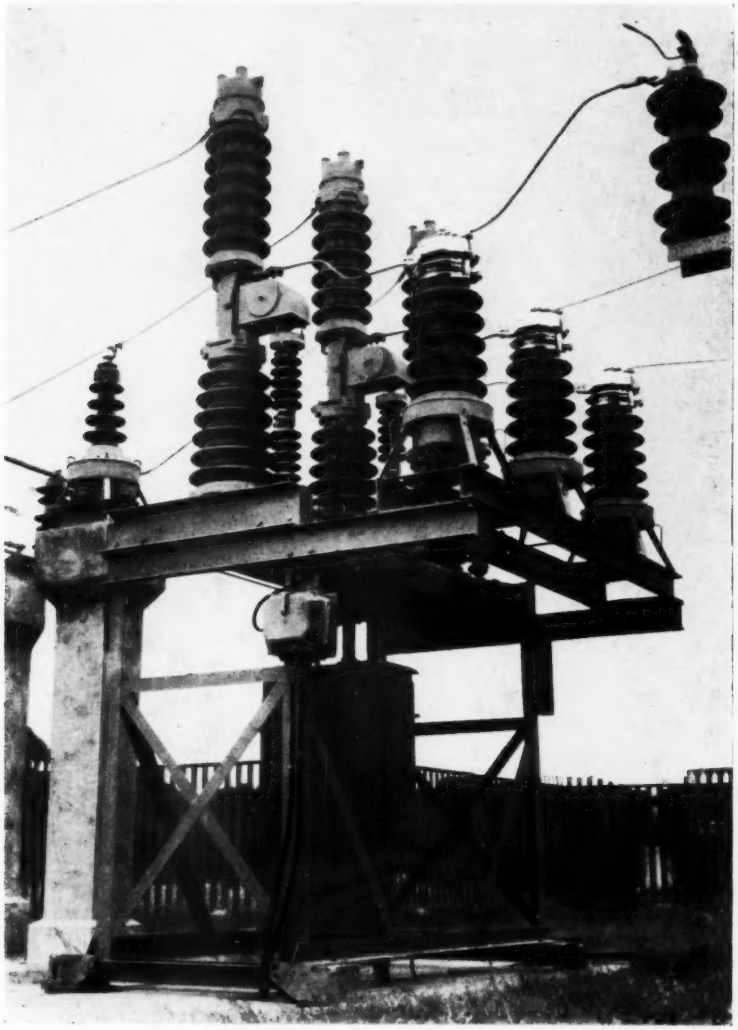
United States and Canada

The United States presents a *different* picture of a great industrial country with very great reserves of easily worked coal. Their speakers have said that the use of nuclear energy in *their* country will depend mainly on its cost relative to power from coal. So they think that by 1975 the production of power generated from nuclear energy will be between one percent and 15 per cent of their total power depending on whether costs are 9 mils a unit or 6 mils a unit. The Canadian position seems to be very similar.

India

The situation in the so-called "under-developed" countries is different again. India is a typical example of an "under-developed country" since its real income per head is only one tenth of that of Braitain. It seems also that India's energy consumption per head is in the same proportion, that is, one tenth of that of Britain. Dr. Bhabha's paper points out that 80 per cent of this comes from the burning of dung which would no doubt be better used for increasing the productivity of agriculture. The production of electricity per head in India is at present 80 times less than in Britain but is now planned to increase 7 fold by 1975. So electrical capacity will have to increase from 3 million kilowatts to 25 million kilowatts installed by that time. The potential hydro-electric capacity is about 35 million kilowatts so that this would be exhausted in the succeeding decade. Dr. Bhabha has said that since the capital cost of hydro-electric development is likely to be less than that of nuclear power development the most important part of the electrification will initially be carried by hydro-electricity. On the other hand nuclear energy will have a specific role to play in areas where hydro-electric development is likely to be slow because of it being combined with irrigation plans which require very large capital expenditure. There are also special areas in India where the construction of thermal stations is at present justified and this part of the load may in future be taken by nuclear power stations particularly where cost of transport of coal is very high.

The development of such countries depends a good deal on the availability of capital resources. Nuclear power may therefore have some special advantages when capital costs of reactors fall since it avoids the heavy capital expenditure on coal mines and no special facilities for transport of fuel. Nevertheless we must recognise that nuclear energy by itself is not a magic key to prosperity for underdeveloped countries. The main requirement is the provision of capital and the



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development of the technology and agriculture of these countries. Nuclear energy will ensure that sufficient energy is available to allow these developments to take place.

Arid Zones

Besides these general aids to development, nuclear energy may have a special part to play in some regions. One of these may be in the development of arid zones. We have heard for example, that our third of the power used in Israel today is devoted to irrigation—for pumping water—and that Israel is planning a four-fold increase in irrigated areas in the next decade. So the uranium in their phosphate rocks should be very important in providing fuel for this increased pumping power.

Dr. Schonland has suggested that in Southern Africa the semi-arid Karoo could become a well watered region if the waters of the swamps of Northern Bechuanaland could be pumped to the Karoo. Nuclear power may help.

Professor Oliphant has suggested that the tropical parts of Australia, particularly the central and western areas, could support much higher populations if life there could be made more attractive and work be made more efficient by a wide-spread adoption of air conditioning. This has already been shown to have a marked effect in other tropical countries. These areas are remote from sources of fossil fuels and short of water. Here, then, is a role for the so-called "packaged reactor" driving gas turbines since gas turbines do not require large amounts of cooling water. Reactors producing power in blocks of about 10 M.W. seem likely to have important applications in remote areas and under-developed areas.

It seems also that recent development in the demineralisation of sea water offer prospects that nuclear power may one day be used to produce large quantities of fresh water from the sea at a reasonable cost for waterless areas near the sea such as S.W. Africa.

Industrial Areas remote from Coal Mines

Nuclear energy will have another special role to play in providing power for industrial and mining areas remote from coal mines and hydro electric supplies. In South Africa coal from the Transvaal and Natal has to be transported to the Cape by an already overloaded railway system over a distance of 1000 miles so that the cost of power is twice that at the source of coal and is about 0.8d per unit. In the Federation of Rhodesia and Nyasaland, coal is transported from Wankie 400 to 500 miles over an overloaded railway system to the copper mines of Northern Rhodesia. By 1962 the Rhodesian will need 4 million tons of coal a year for power generation alone and this is the whole predicted output of the mines at that date. Some help will indeed come from the hydro-electric development of the Kariba Gorge but this is 250-300 miles from the mines and transmission costs are likely to be abnormally high and will double the cost of power at the source. So Dr. Schonland suggests that by the 1970's nuclear power stations of considerable size—perhaps upto 1000 megawatts—could be contemplated, in the copper belt itself. By this time nuclear power is likely to be important also at the Cape.

There are many others regions in the world where mines are remote from fuel sources. Thus in Candaa the present cost of diesel-generated power at Port Radium and Beaver Lodge is four times the normal cost. Similar cost levels prevail in mining areas of Australia such as Broken Hill. The local application of nuclear power should encourage the production at the mine itself of highly refined metals by electrolytic and electric-thermal processes. In this case capital investment might be diverted from the building of railway systems to carry coal to mining areas and ores and crude metal products back to industrial areas and instead the capital might be used for nuclear power units. Nuclear power units for such areas would have to be built in a transportable form and would probably have to use enriched fuel with provision for some regeneration of fuel. Such units could probably be built within 5 years to produce power at about twice the cost of power from full scale stations. In such areas however, these costs would be acceptable.

There are *other* processing industries, such as cement, or pumlp or paper, often located away from fuel sources where energy is required in the form of high temperature heat. Reactors producing high temperature gas might be developed for such purposes.

Industries such as aluminium could absorb the output of the largest scale nuclear power plants now contemplated. These plants may produce power at costs well below that for coal stations in the second decade, though they are unlikely to compete with the lowest cost hydro power. Nevertheless, in the long run their use may lead to large scale shifts in the location of metallurgical industries.

Transport

We have not discussed in the Conference the possible application of atomic energy in transport which today consumes about 8 per cent of the energy of the world. The United States has already shown that the nuclear propulsion of ships is technically feasible but only a limited amount of information on the economies of nuclear propulsion is available. A fairly recent discussion in the United States Congressional Committee suggested that present nuclear propulsion systems would lead to costs about ten times normal commercial costs. On quite general grounds it would appear that commercial nuclear propulsion of ships is not likely to develop until the cost of that energy from pure fissible material is less than that of fuel oil at £6 per ton. This obviously requires that Plutonium or U233 should become available as a by-product of reactor operations at a cost of appreciably less than £6 per gram. Regeneration of fuel and high burn-up in fuel

elements will help. Thus if Plutonium becomes available at £3 per gram, and 50 per cent burn-up and and 33 per cent thermal efficiency is achieved, this would lead to fuel costs of 0.3 d per KW/hour, which would be commercially interesting.

It seems quite possible that these conditions will be reached by the time large scale breeding is achieved. But many other technical considerations have to be taken into account in determining the desirability of commercial nuclear ship propulsion. The engineers responsible must in particular be specially concerned with potential hazards due to leaks of radioactivity in such confined quarters. For such reasons I do not myself predict a rapid development of commercial nuclear propulsion.

In the present state of nuclear technology, chemical and metallurgical operations play a major part and their role is likely to become more important as we progress towards the development of breeding, for by then nuclear fuel costs will be due almost entirely to chemical processing costs. Some of the homogeneous nuclear power plants of the future may indeed be chemical plants of highly specialised nature. Even with solid fuel reactors there are considerable possibilities for reducing recycling costs by simpler processes in which some of the important radioactive waste products which poison the chain reaction are removed without dissolving the fuel elements in acids for solvents. Since the spent fuel elements will be highly radioactive, remotely controlled operations will be necessary—here is a good application for the automatic factory.

Problem of Waste Disposal

The development of nuclear energy will inevitably lead to the production of large quantities of radioactive fission products. At present they are looked upon as a nuisance and a problem for the future since they have to be stored for long periods of time. However it seems that the radiation from these waste products will find important uses. The gamma radiation from spent fuel elements can be used in the first few months after their withdrawal from the reactor, and we have heard of several such applications. Our discussions on waste disposal have shown that the long lived useful products radiocaesium and radio-strontium will be separated from the rest of the fission products and concentrated into radioactive sources. The radioactivity of the remaining fission products will be concentrated and stored until the activity decays to low enough levels for discharge to the sea or fixation. The cost of this storage has been estimated to be less than two per cent of the cost of nuclear power and will prbably be offset by revenue from the sale ot the useful radiocaesium and strontium, which will become available in source strength varying from kilocurie sources of radiocaesium for radiotherapy to megacurie sources for industrial application.

Work on the application of radiation needs to be pursued on a much wider front before its possibilities can be properly evaluated. It already seems certain that sterilisation of pharmaceuticals and some medical supplies could be carried out with safety as soon as processed fission products are made available in quantity. The sterilisation of food has already been strikingly demonstrated, but the processes require much further study and trial before it can be certain that it is acceptable and safe for general use.

Insect Control

A most promising field of application of radiation is in insect control. Successful large scale experiments have been reported from the U.S.A. on the eradication of the screw-worm by liberating large numbers of males rendered infertile by suitable doses of gamma radiation. In this Conference we have also heard of the control of the parasitic disease Trichinosis which is transmitted by larvae in pork. Irradiation of hog carcases sterilises the female and breaks the disease cycle. In Great Britain, joint studied by the Forest Products Research Laboratory and the U.K.A.E.A. have shown that the life of insects infesting wood can be markedly shortened and their ability to lay fertile eggs prevented, by doses much smaller than those needed to kill the beetles and larvae (Lyctus species). The eggs of the death watch beetle are rendered infertile by doses of a few thousand roentgens. The preservation of historic timber and valuable furniture is an exciting possibility. Entomologists ought to look for other applications in this field.

Chemical Synthesis

Chemical synthesis is an application that could use large quantities of fission products. It is accepted that chain reactions offer the best hope of economical utilisation. The fields of polymer modification and polymerisation have been studied actively. The very high conversion rates observed in some emulsion polymerisations should be noted. Halogenation and oxidation have been neglected relatively. It is not to be expected that industry will set aside well-established processes unless the use of radiation offers some well-marked advantage. Too much current effort is devoted to existing fields of production. In Great Britain, industry is studying such fields with a view to improvements and new products. We are also sponsoring basic research in radiation chemistry and less profound studies in the organic chemistry field. The irradiation of concentrated solutions, non-aqueous solvents, new approaches to chlorination and molecular rearrangements are being studied. Clear selective reactions of decomposition and oxidation have been revealed and high yields suggestive of chain processes have been observed in unexpected places. New pathways in sugar synthesis and degradations have been found, but it is too early to say that economic application is proven. The systematic study of organic radiation chemistry is still in its infancy, but seems to offer the best hope of progress. Radiation may also be applied in future to the fixation of nitrogen if it becomes readily plentiful and cheap.

Professor Hevesy has spoken in his evening lecture

of the important part radioactive elements are playing in the development of our knowledge of living organisms. So I do not need to speak about this myself except to say that I believe this will be a major contribution to the development of our understanding of the biological world and this in turn will inevitably contribute to human health and well being.

Responsibility for Safety

In planning the development of nuclear energy during the next two decades we have a great responsibility to see that it is developed in such a way that it is an essentially safe industry and that it does not produce a substantial new hazard to the general population of the world.

We have been fortunate so far in having been able from the beginning to lay a sound scientific basis for health protection by the devoted labours of our biologists and health physicists. I do not think that any other new industry has had the advantages of such preparation. The immediate effect of radiation on living organisms has been studied by very large numbers of experiments on animals and as a result of this the International Commission on Radiological Protection has prepared a list of safe levels of radiation and of the amounts of radioactive materials which can be ingested. These recommendations have been incorporated into the working practice of all well run Atomic energy organizations and should from the basis of world wide Codes of Practice to be promulgated by the World Health Organizations.

We have also a responsibility to the general public in our own countries in seeing to it that possible accidents to reactors cannot produce an appreciable hazard to surrounding populations. Here again Codes of Practice are being drawn up by experts who really know the hazards and the problems of control. The next is to compare experience and ideas of different countries and to agree on International Codes of Practice. Whilst we are accumulating experience of reactor operation much can be done to reduce these risks by adopting a policy of enclosing reactors in buildings which are so constructed that they could contain any large scale leakage of radioactivity resulting from a reactor accident.

Its Genetic Effects

The still larger problem of the long term effects of raising the world wide level of radiation by the dispersal of fission products has been discussed in our chemical and biological sessions. Our knowledge of the genetic effects of radiation on human beings is at present much less than our knowledge of the effects on animals and we should press on with research on human genetics and in the meantime adopt a cautious policy. We have some yardstick to guide us in the general background level of radiation due to Cosmic Rays, Potassium in our blood, and Radium in the walls of our houses and in the ground. This gives us all a radiation dose during our reproductive period varying from about 3 Roentgens to 6 Roentgens depending on the locality. Investigations are proceeding in Britain and the United States by Committees of the Medical Research Council and National Academy of Science which should help us to decide by how much the general background level of radioactivity may be allowed to increase without appreciable harm. This may well be followed by International discussion of this problem. We may then hope to prepare International Codes of Practice which will determine the amounts of radioactive gases which may be safely discharged to the atmosphere and of radio-active liquids and solids which may be safely discharged to the ocean.

I am quite sure that by such means we can carry out this great new development in a far safer way than has been the case in any other new activity of the human race.

We have still to discuss in our closing session the important question of how international co-operation can help in speeding up this vital new development. Atomic Energy by its world-wide effects in the field of public health can for this reason alone benefit by international co-operation.

We must also not lose sight of the fact that its products—the fissile elements—rare potentially very dangerous materials, not only to public health but also because of their explosive possibilities. Inter-International co-operation in preventing the diversion of such materials to explosive uses could therefore be of the greatest importance.

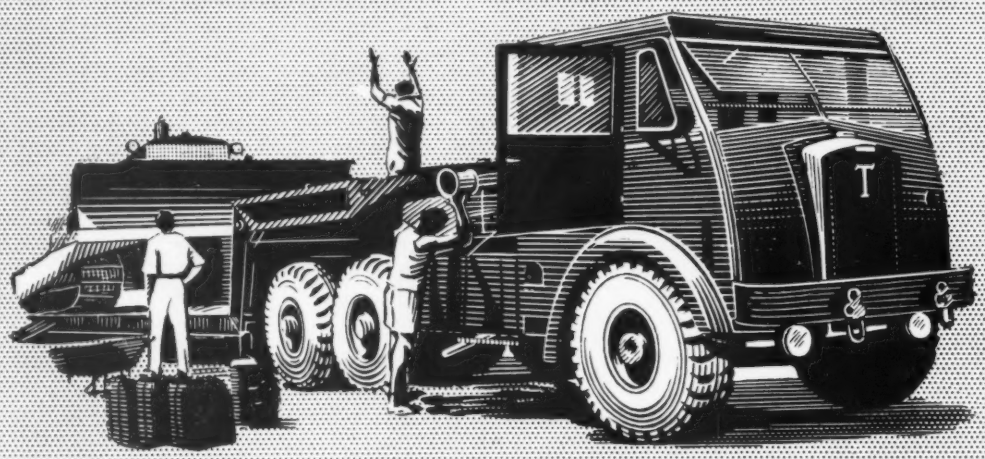
In Western Europe we have made a beginning in a modest way in the European Atomic Energy Society in discussing our common scientific and technical problems, and this has already proved to be valuable.

The United Nations Organization is in process of giving birth to a much more ambitions offspring—the International Atomic Energy Agency. We must all hope that its birth will not be too painful or too long delayed. The Agency, wisely guided, could do a great deal to ensure that the inherent dangers in our development are prevented.

Having looked into the cloudy, crystal ball with my imperfect eyes I feel quite sure that the real picture 25 years hence will be very different. For scientific and technological progress is today so rapid that our predictions must be subject to great uncertainties. Rutherford in 1937 could not predict fission and did not believe that nuclear power was likely. Now power from fission reactions is assured. I would like tonight to have been able to predict when the exciting prospect of power from fusion reactions would be achieved. But although we are working seriously on this problem in Britain, my vision is not good enough for that. I am not as bold as our President. The experimental physicist must inevitably have a greater appreciation of the problems and difficulties than the theoretical

(*Continued on page* 8)

FOR THE BIG, TOUGH JOBS...



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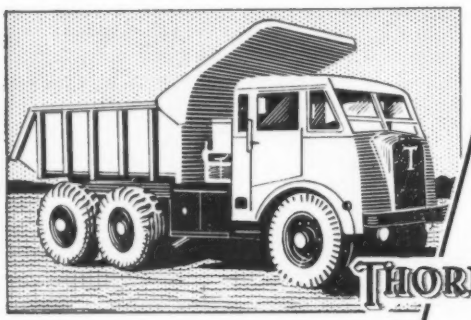

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TG/2

Growing Importance of Engineers in India

By

V. T. KRISHNAMACHARI

Deputy Chairman, Planning Commission, Government of India

AUTHOR

Being the Inaugural Address delivered at the inauguration of the Refresher Courses, University of Roorkee on 1.11.1955

The inauguration of these courses, as the Vice-Chancellor has pointed out to you, marks one stage in the advancement of this Institution from a College to the status of a new University. To me it is a special pleasure to come and inaugurate these refresher courses. Mr. Khosla has already explained why these courses are necessary. I would like to elaborate further that point and as I see before me many of the students of this College I would like to remind them of the great part the engineers played in the implementation of the First Five Year Plan. There are certain facts and figures which I would like to place before you and make those of you familiar who are studying in the College as these facts may perhaps be of interest of them. In the years during the First War and the Second War we did not have any engineering works of great importance in this country. The reason is apparent that the country recovered from the effect of war. There was depression during which progress could not be made in any field of constructive activity. When the Independence came, there began a period of intense activity in this field. The first Five Year Plan attached considerable importance to programme of irrigation and power, to the construction of highways, shipping ports and so on. Some figures which I have given on the previous occasion may give you an idea of this sort of programme thus embodied in the First Five Year Plan. It is satisfying to say that the 1st Five Year Plan was a modest one. It is more modest in relation to the needs of the country but when compared with what was done before, it marks an an enormous advance. Let me give an example. When partition came the capital value of the large irrigation works that fell to the share of India was nearly 110 crores of rupees. In the 1st Five Year Plan on multipurpose projects and large irrigation projects the actual expenditure incurred is Rs. 600 crores. Of course when I say the capital value of 110 crores, in the modern terms of cost and prices it must be much more but you can easily understand that expenditure which we have incurred in these five years is allowing for the depreciation of money, atleast equal to the expenditure on all the irrigation works that fell to the share of India at the time of the partition.

Take another instance. All of you are familiar with the tubewells. There are many of them in this State. When the First Five Year Plan began we had about 2500 tubewells in this country. In the first five years of this Plan we have completed 5,500 tubewells. On minor irrigation works we spent in these 5 years atleast as much as the cost of all the minor irrigation works existing in this country at the beginning of the Plan. You will all easily understand what all these developments mean. Within this period of 5 years India has attained as much development in irrigation as took place in all previous years of its existence. I cannot claim that in any other fields the progress has been equally spectacular but there has been very great progress alround. We have got through an impressive programme of national highways with new bridges in many parts of India. Regarding building construction I cannot give you exact figures of the programme but it has been a very large one indeed.

There is also a programme of railways, rehabilitation and power development and so on. All these examples I have given to you will indicate to you the great part the engineers of all ranks have played in the implementation of the 1st Five Year Plan. It will also be of interest to know that in the 2nd Five Year Plan we are going to undertake a much larger programme than even in the First Five Year Plan. We have been examining the Plans of various State Governments in the recent weeks. We have also examined the plans of the Central ministries. They will give you some idea of development that we are looking forward to bring up during the 2nd Five Year Plan. In irrigation and Power we hope to spend about 60% more than that we did in the 1st Five Year Plan, about 950 crores as against 560 crores in the First Five Year Plan. We propose to spend more than double the expenditure for national highways. The expenditure on engineering works of railways will probably be over three times the expenditure of the 1st Five Year Plan. On ports etc. we shall probably spend about 3 times as much as we spent in the First Five Year Plan. These are impressive figures which will give you an idea of the increasingly great part which the engineers will be called upon to play in the 2nd Five Year Plan.

Those of you who have read the First Five Year Plan will know that for irrigation and power programme, the Planning Commission envisages a 20 years plan the object of which is to double the area irrigated by large irrigation systems in this country and to increase the production of electrical power. So far as we can see now we shall need more and more engineers in all the fields in the building construction, highways, bridges, irrigation and electrical power, ports and so on. This Institution, therefore, will have a great part to play in India's development in the future. I, therefore, congratulate this University on having set up these Refresher Courses. As Mr. Khosla has stated, it happens that engineers engaged in the every day duties do not find time to keep in touch with the latest advances in their particular fields. It is, therefore, a very good idea of this University to bring them here periodically so that they may know what has happened in their respective fields during the years they have been working in their respective fields. They will go back with their knowledge widened and with the opportunity to apply in the fields the knowledge and experience they gained during the courses here. I am quite sure that this will assist them actually in the future carrying out of very large programme to which I have referred.

We are, therefore, grateful to the State Government and to the University authorities for having initiated the refresher courses at the University of Roorkee. This being the first series of the refresher courses I can understand there are various difficulties on the part of the states in sending their officers for these courses but when more courses have started these difficulties will have been surmounted and I have every confidence that as time goes on more and more officers will be deputed by the State governments to undergo these refresher courses. There is no doubt whatever that the efficiency of these officers will be increased considerably by the experience and knowledge they gain in these courses. More than that the engineers and officers will have opportunities of coming into contact with the officers from other states exchanging experience as to what is happening in other parts of India. The developments to which I have referred that are taking place all over the country, it is true that the scope for large multi-purpose projects costing over a crore of rupees in certain areas is limited and it is also true that the Government can take up only a limited number of them at a time. But all over the country there are quite big projects in which engineers are doing their work. When engineers from all the states meet here in these refresher courses and exchange ideas about what is happening in each state, I had no doubt the horizon will be extended and the engineers will come to know how each individual effort in every state fits in with the national plan of improvement. During the years I have been associated with the Planning Commission, nearly six years now, I have attached a great deal of importance to the work done by the engineers and I have watched with keenest interest the increase in the efficiency with which these very important works are being carried out throughout the country. I see the efficiency growing month by month in these last years of the First Five Year Plan. The progress made is exceedingly good. After the initial difficulties, which always attend the implementation of big projects, have been overcome, training programmes have been chalked out on a more impressive scale and the efficiency in implementation of plans have been increased enormously.

It gives me great pleasure to acknowledge this in public and to say how grateful the Planning Commission is to engineers all over the country for the very important work they are doing.

(*Continued from page* 5)

The Future of Atomic Energy

physicist. However, my faith in the creative ability of the scientist is so great that I am sure that this will be achieved long before it is essential for man's needs.

We must all hope that the statesmen who control our destinies and whose vision has made this Conference possible will continue to liberate the creative ability of the scientific world and so enable it to produce these benefits which I have so imperfectly attempted to predict.

Inter-State Rivers Tribunal to settle disputes

The Rajya Sabha after a prolonged debate approved the Irrigation and Power Minister's Inter-State Water Disputes Bill which seeks to provide for the appointment of one-man tribunals for adjudication of disputes relating to waters of Inter-State rivers and river valleys.

By an amendment, the House decided that the Government of India would first have the opportunity to settle the dispute by negotiations. In case of the failure of the negotiations, the Government would refer the dispute to the tribunal whose decision would be final and would be binding on the parties concerned.

The Bill provides for the constitution of one-man tribunal which could appoint two or more persons as assessors to advise the tribunal in the proceedings before it. The judge for the tribunal would be named by the Chief Justice of India and would be either a judge of the Supreme Court or High Court.

Objection was taken by a section of the members against this one-man tribunal. This section wanted that the tribunal should consist of two or more persons, as it was argued that two minds were better than one. Moreover, it was pointed out, the tribunal should be enlarged as the case disposed of by the tribunal could not be taken before the Supreme Court or any other court by the aggrieved party or parties.

Defending the one-man tribunal, Sri J. S. Hathi, Deputy Minister for Irrigation and Power said that the intention behind the proposal for one-man tribunal was to secure expeditious settlement of the disputes.

The House approved the one-man tribunal proposal after a long debate.

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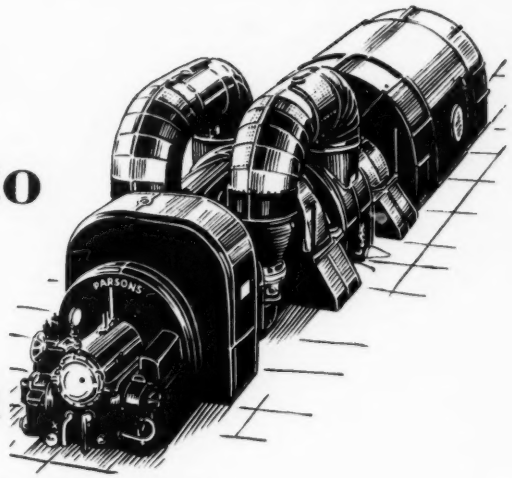

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Matatila Dam

By

B. P. SHARMA

Executive Engineer, Mata Tila Dam Division, U.P.

AUTHOR

Of those numerous important River Valley Projects which will sweep out the barrenness and dust from the skirts of our motherland and will enfold a carpet of greenery and verdure to the pleasure of teeming millions, the Mata Tila Dam will not lag behind in pouring its benefits by the end of the Second Five Year Plan.

On a site chosen by the suggestions of Assistant Geologist, Mr. S. C. Avasthi and Consulting Engineer, Mr. J. L. Savage, upon the Betwa River about 35 miles from Jhansi, this promising project will be prepared in the meagre sum of Rs. eight crores and will shower its potentialities for power and irrigation through a series of Storage Reservoirs on the Betwa River which has an annual seasonal run off of 3,00,000 M. Cft. The masonry portion about a half mile in length is designed as straight gravity structure, 120′ height tied to about 4 miles of afflux bunds at the flanks by producing the end section of the dam into the earthen section. Afflux Bunds are designed for 4 : 1 HG with impervious core, 1½′ thick stone, rubble pitching on the upstream face and drainage gallery at the downstream end.

The lake formed by the reservoir will submerge 32,320 acres with reservoirs full :

Uttar Pradesh	..	8,470 Acres
Vindhya Pradesh	..	15,600 ,,
Madhya Bharat	..	18,250 ,,

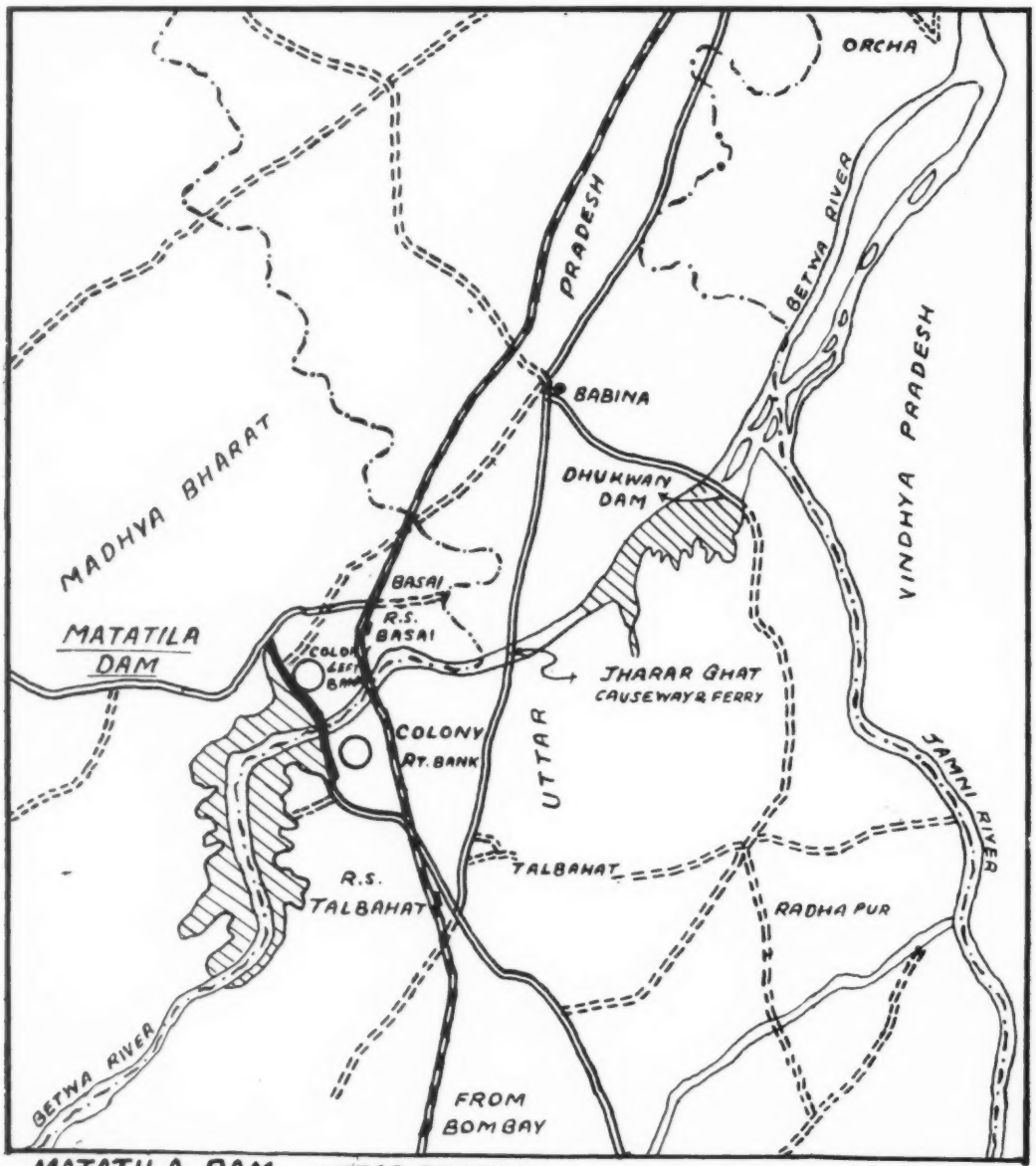
of which 8,000 acres is cultivated land. For all this loss to the 7,500 people, ample provision has been made by the authorities. Enough cultivable land has been harnessed to resettle them. This storage is to be released into the Betwa River and carried over Dhukwan Dam upto Parichha-Dam, where it is picked up by the existing Betwa River Canal System which forms an extensive Betwa-Pahuj and Pahuj-Sind Doabs. When completed, the project will provide 4,05,000 acres of irrigation in the above doabs with 770 miles of new channels. The construction and administration of the canals in all the States would be the responsibility of the Uttar Pradesh Government. The irrigation charges will be recovered by the States concerned and passed on to Uttar Pradesh.

Huge gates of 60′×23′ covering the open spillway will given an effective storage of 40,000 M.Cft. Apart from irrigation the various penstocks and ancilliaries at a cost of Rs. 25 lacs will make use of the storage of 20,000 KVA generation in the Second Five Year Plan. Thus the unimaginable reduction in the cost of electrical energy from 9 annas per unit in Jhansi, Jalaun and partly Kanpur districts will be a unique blessing of this project.

Every day as stone upon stone is laid to touch the completion level of 1020, and as every modern earth-moving equipment unit spreads its apron, one is appalled to think of the final majesty of such an achievement. Ten thousand labourers drawn from different parts of India, working on masonry portion and a thousand mechanics, operators and greasemen harnessing the most modern devices of mechanical engineering will one day see their perspiration in stone and earth.

One of the biggest maintenance garages of Earth-moving Equipment in Uttar Pradesh combining of 20 C-Roadsters, 20 Tournapulls and a number of tractors, bull-dozers, tournadozers, road-graders, tankers, etc., all the time efficiently running, stands out to conquer the distorted gifts of nature. In all this humdrum of work, and busy life, provision has been made for all those who are so sincerely shouldering the responsibilities. Quarters for workers, electricity, hospital, recreation, market and whatnot, every daily requirement is looked after with precise care.

The project is attractive, sound and useful beyond doubt a notable contribution to the largest irrigation system of India. It will help improving the rural economy of 2 lac population by additional food production to the extent of 80,000 tons. The supply of power to the neighbouring places will be a boon.



MATATILA DAM UTTAR PRADESH.
VICINITY MAP.

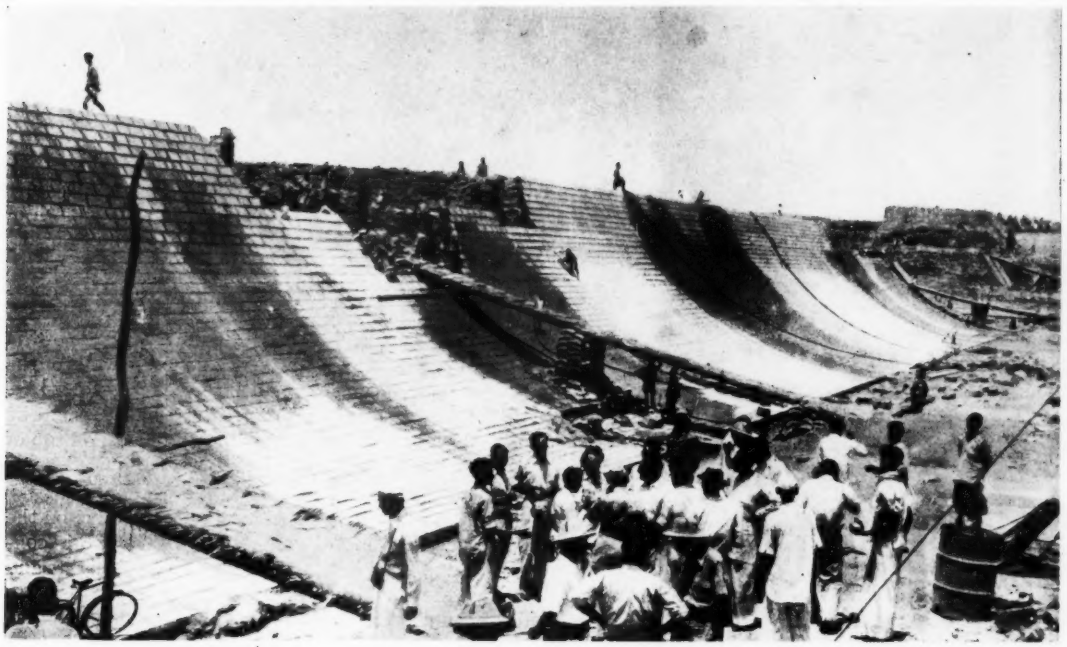
Some of the salient points regarding the dam are :

1.	Total length of the Dam ..	20,920 ft.
2.	Length of spillway ..	1,600 ft
3.	Length of non-spillway ..	740 ft.
4.	Maximum height of non-spillway ..	120 ft.
5.	Maximum height of spillway ..	140 ft.
6.	Number of flood gates ..	23 nos.
7.	Size of flood gates ..	60′×23′.
8.	Quantity of Earthwork in Dam	1,600 lacs Cft.
9.	Quantity of Masonry in Dam ..	1,162 Cft.
10.	Cost of dam ..	531.06 lacs
11.	Cost of total project ..	798.55 lacs
12.	Expected date of completion ..	June, 1956
13.	Labour ..	15,000 hands per season.

Progress of Mata Tila Dam

There was feverish activity on all jobs going on in the River Bed portion of the dam due to the impending advent of the monsoons.

It had been proposed to attain the level of 935 in the River Portion and the level of 960 in the non-Spillway portion of the entire dam this year at the



Spillway under construction, June 1955, R. L. 935.

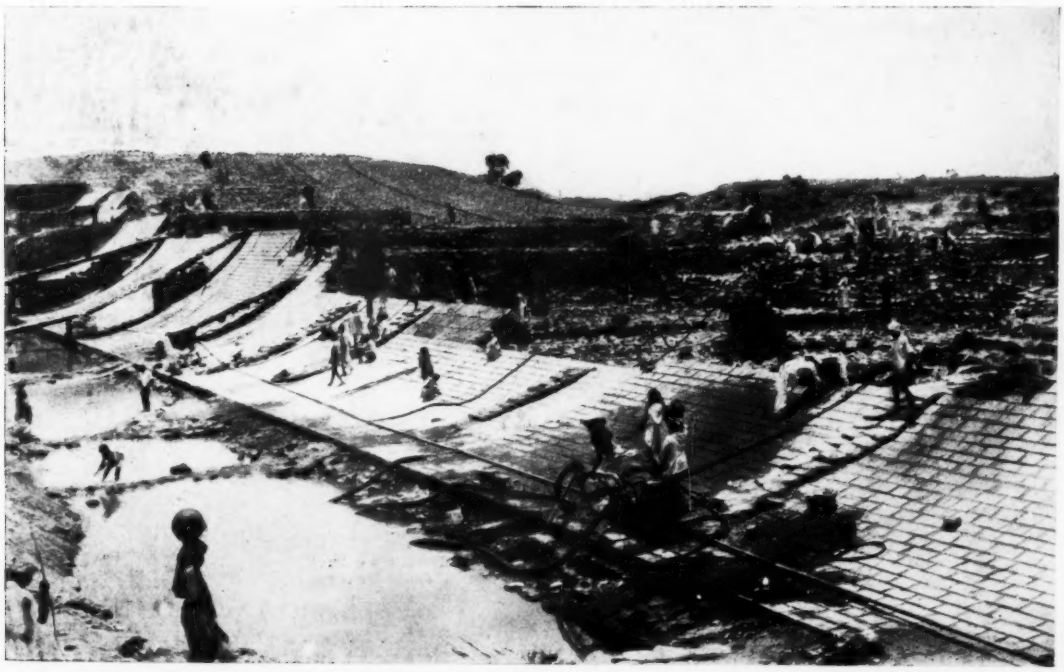
close of the working season. But due to the incidence of a 5 ft. thick weak layer in Gate No. 6 and No. 7 the foundation had to be taken down to a depth of 45 ft. below bed level which caused a delay in starting masonry in this reach. Out of the entire 2420 feet length these levels were attained except in the folowing portions :

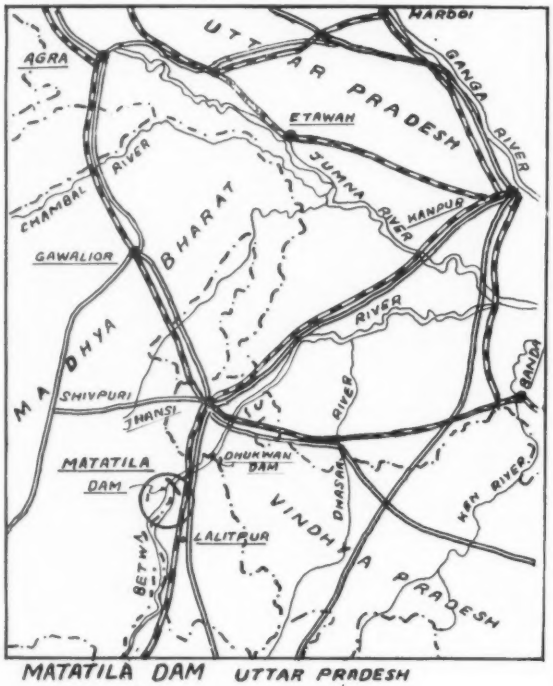
1. Gate No. 4, 5 and 6/1 .. Total length 175 ft. Level attained 930 ft.

2. Gate No. 6/2, 7 & 8/1 .. Total length 142 ft. Length attained 925

The Masonry of the dam is now everywhere 20 to

Spillway under construction, June 1955, R. L. 916.





MATATILA DAM UTTAR PRADESH
INDEX MAP.

25 ft. above the river bed level. Though the total height will be 105 ft. approximately half of the total quantity of the masonry has already been completed. This is because the width of the dam is considerable at the base as well as a large volume of the masonry is done in the foundations below the river bed.

The construction of two river sluices during this month deserves special mention. The river sluices are tunnels in the body of the dam for letting out the water required for irrigation. These sluices are 5 ft. wide and 10 ft. high and three men can comfortably walk inside them. Their length is 70 ft. and the level of their floors has been kept at R.L. 920, which is 5 ft above the river bed level.

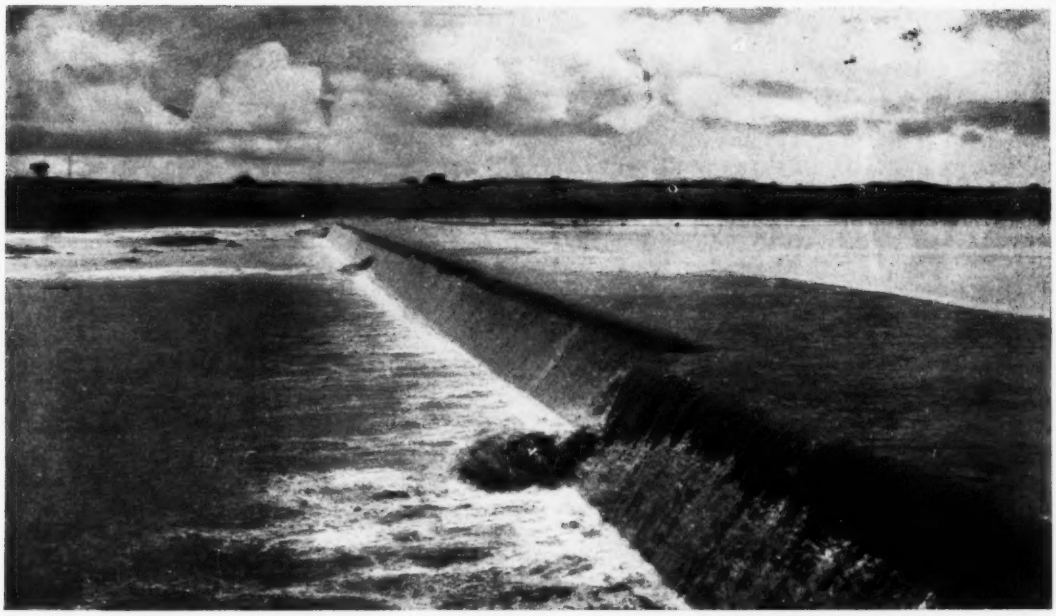
There will be a "pressure head" of 100 ft. depth of water on these sluices and they will be able to discharge 2000 cubic feet water per second. The water will attain a very high velocity through the sluices due to this large pressure head and it may have a dangerous scouring effect on the inner surfaces of the sluices. Therefore the 2 ft. thick concrete walls of the sluices have been protected by a covering of $1\frac{1}{4}$ ft. thick granite stone masonry. These sluices shall be controlled by winches that will be mounted on top of the dam at a height of 100 feet above the sluices.

The staff was busy 3 shifts a day for 15 days on the construction work of these sluices. The work continued unabated in the night under electric lights and during the day time when it must have been 140 degrees under the hot sun. This had to be done because the flood could come any day after 7th June. However the work was completely finished before the onslaught of the floods.

The construction of these sluices was very necessary this year. The river water is to be diverted through them during the next working season for which there will be no difficulty now and the entire length of the dam will be available for construction work to proceed on.

The river bed had to be vacated for the flood season. All the pipe lines, air lines, electric lines, temporary

River Water passing in Gap, July 1955.



River overflowing on Spillway, August 1955.

bridges and other machines and pumps had to be removed to safety to the banks. It may be mentioned here that the Betwa brings as big a flood at Mata Tila Dam site as the Ganga brings at Hardwar.

The rains started in full swing on the 25th June when all masonry work was stopped. The heavy earth-moving machines were also stopped as they cannot operate in wet condition of the ground.

The work on the earthen dam was also in good progress. The slopes of the earthen dam on the right and left bank were pitched with a two ft. thick layer of granite stone to protect it from being washed away by the river.

With the end of this season, 8 crore C.ft. out of the total 16 crore C.ft of earthwork was completed at Mata Tila. Now 40 or 30 feet of height remains to be done in the entire length of 4 miles, on the earthen portion of the dam.

Two construction years finish with this month at Mata Tila Dam. More than half of the work has been finished and there appears to be no doubt that this Dam will start supplying the much needed water for irrigation by the month of November-December of the year 1956.

Non-Spillway Left Bank as on Sept. 1955, R. L. 980.

Bihar's Plans for Gandak Project

The Government of Bihar proposes to raise Rs. 5 crores in five years by selling certificates like the National Savings Certificate for the execution of the Rs 36-crore Gandak Project. Details of the scheme are still being examined.

The Gandak Project, included in the second Five Year Plan, is expected to provide irrigation to 2.6 million acres and generate about 25,000 kW.

The overall plan of development of the Gandak valley will comprise :

(1) The construction of a barrage across the river Gandak at about 1,000 feet below the existing Tribenai Canal had sluice, for delivering the supplies of water from this river into the two offtaking channels on either side for Irrigation and for generating hydro-electric power. A road bridge is also proposed over the barrage to open up communication with the right bank of the Gandak particularly in the Nepal territory. It is also proposed to extend the piers for putting up a railway bridge when found necessary.

(2) Two canals will take off from the two banks of the Gandak. The length of the main western canal in Nepal will be 11 miles and it will flow over 75 miles before it enters the district of Saran in Bihar. The left bank canal will be entirely in Bihar and irrigate the area bounded by the Sikrahana and Burhi Gandak on the north and east, the Gandak river embankment on the west, and the railway line along the river Ganga on the south. Large areas will also be irrigated in Nepal and Uttar Pradesh.

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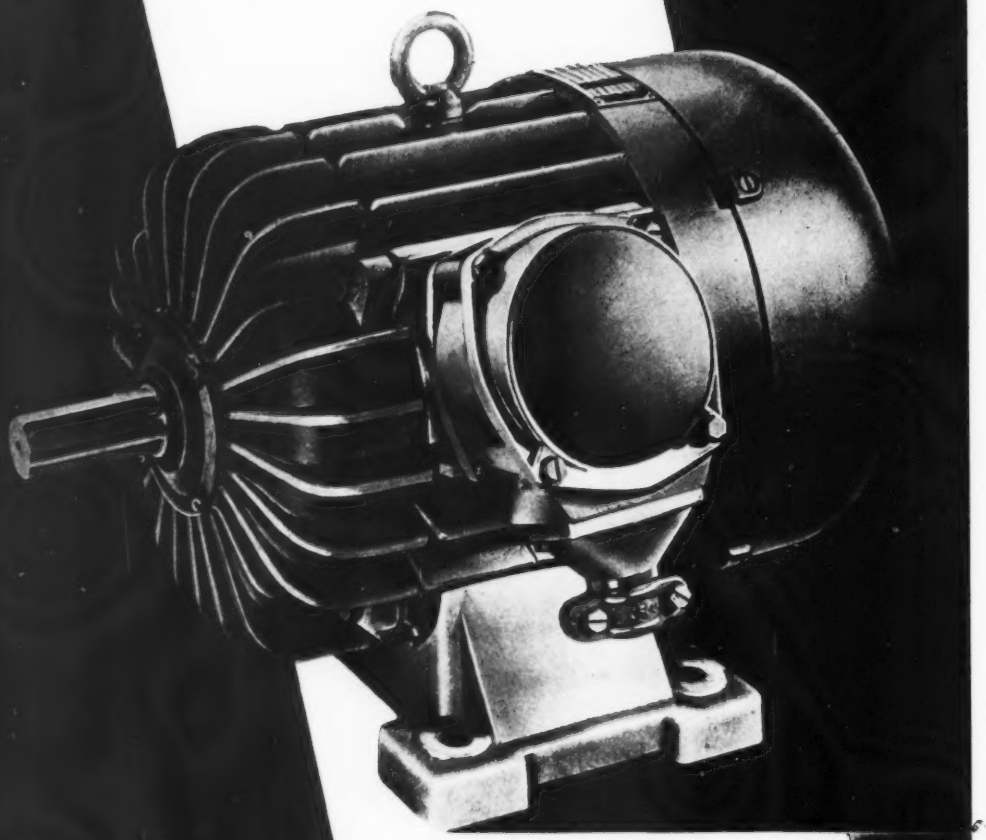

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Economic Effects of Irrigation—A Review

By

C. S. PARTHASARATHY

Asst. Chief, Natural Resources Division, Planning Commission, Govt. of India

AUTHOR

The publication styled "Economic Effects of Irrigation" (1948) by Dr. D. R. Gadgil contains the results of surveys, undertaken by the Gokhale Institute of Politics and Economics, Poona, on behalf of the Government of Bombay, during 1939-40 in the irrigated areas under the Godavary and Pravara Canal systems in Nasik and Ahmadnagar districts of Bombay State. The report was submitted to Government in 1942 and was published only in 1948.

The report throws a great deal of light on the quantitative relation between different economic activities in India rural economy and on important problems of the results of investments on employment and distribution of income, before and after the advent of irrigation facilities. The immediate aim of the survey was to assess the total direct and indirect benefits from an irrigation project. The many aspects of the results of irrigation and the direction in which direct and indirect benefits may be traced, are dealt with. The advent of canal waters modifies the economy even of the adjacent non-irrigated tracts. Another aim of the survey was to study conditions of second class irrigation works in areas where well-irrigation was fairly common.

Some attention has been paid in the report to costs incurred by Government or by private enterpreneurs in clearing and developing, etc., the land and making full use of irrigation. No consideration has, however, been given to the problem of community building. The lands watered by the Godavari and Pravara Canals system had been developed for centuries past. Therefore, a survey of this region was calculated to bring out fully the results of the transition from dry farming to irrigated farming. The investigation was undertaken more than 20 years after irrigation from the canals had begun.

The survey is broadly divided into two parts. The first part deals with the effects of the irrigation system from the broader point of view of the whole community. The second part deals with an estimate of the total income received, directly or indirectly, by the various State authorities as a result of the changes following the construction of the system of irrigation in the tract. The data relating to *four* comparative sets were obtained by conducting farm business surveys in *four* pairs of adjacent areas, the distribution of which was as follows. Two were in the Kopargaon Taluks to sample conditions in the area in which *irrigation was most concentrated*, one in Nevass to illustrate conditions towards the *tail-end* of the canal system where *water supply was not guaranteed* for the entire twelve month period and the fourth in the Niphad Taluka on the Kadwa canal system which was specially included in the investigation to study conditions on *second class works* in an area where *well irrigation* was also fairly common. In the first group there is considerable emphasis on garden produce. The second and third represent typical heavy irrigation agriculture with sugarcane dominating the farmer's economy. The fourth with a water supply not completely assured shows a variety of the ordinary dry crops grown under irrigation. Each set of farm business surveys covered farmers in four nearby villages. Two of the villages were under command of the canals and the other two villages were in a *contiguous* area which was not under command.

The investigation was mainly directed towards estimating the nature and extent of the direct and indirect effects of irrigation on the whole community. The really important problem is the measurement of the difference made by irrigation to agricultural activity and production.

The following are the more dominant results of the Surveys :

Investment

The incomplete character of the transformation from dry to irrigated economy towards the tail-end of the canal system is shown by the fact that the average investment of farm business in the irrigated villages is not markedly larger than that in the neighbouring dry villages. It is stated that the capital resources of the farmer in the area surveyed may be said to have been built up from the savings of the previous years. These, thus, represent in themselves the lasting effects of irrigation.

Crop Receipts

The value of the production of important crops shows variations between the irrigated and dry groups All irrigated groups record very substantial incomes from the sales of sugarcane and gur. The cash-economy is dominated entirely by the production of sugarcane.

In those groups in which the receipts from cash-crops mount to very high figures, the proportion of total income in terms of value received by the raising of these crops, becomes proportionately very small. And this is the main difference in the farm economy of dry and irrigated groups.

Value of Gross Production

The total value of all produce of the farm (crops and livestock) is a good index of the increased size of business activity made possible by irrigation. This in effect, is the measure of the total direct effects of the public investment in the canal system together with the private investment in irrigated farms. The survey shows that the construction of canal system made possible an increase in the size of the agricultural business from the neighbourhood on an average, of Rs. 650/- in typical *dry unit* to round about Rs. 1500/- under *second class irrigation* and Rs. 4,000/- in intensive irrigation, dominated by sugar cane. The results are claimed to present series of generally comparable picture and yield direct concrete measures.

Social Income and its Distribution

The figure for the year 1939-40 show that while, in all dry groups as well as in irrigated group, I_4 it varied from about Rs. 120/- to Rs. 200/-, it went upto Rs. 350/- in irrigated group I_1 and to between Rs. 750/- and Rs. 800/- for irrigated groups I_2 and I_3. A part of the enhancement, therefore, might be attributed to irrigation.

The rate of rent of per acre of lands in irrigated farms are, on an average, much higher than the rates in the dry groups. This increased level of rents, which is in the main due to the construction of the canal, represents a purely "unearned" income i.e. the landlord has to incur no additional charges or to undertake no fresh investments in order to earn the increased rents.

Employment

Both casual and contract labour is employed to a very much greater extent in irrigated farming than in dry farming. Irrigated group I_3 gives employment to about the same number of family labour units per annum as dry group D_3; but, in the dry group, the employment of labour is concentrated in a comparatively small period. The increments brought about by irrigation in the employment of family labour may be placed at about 20 to 25% of that required in dry farming. While the average dry farm employed approximately 1.2 units of family labour per annum, the irrigated farm offers employment opportunities to about 1.5 units. Table No. 28 in page 124 sets out the total estimate of employment and investment.

The last division of the total social income is represented by farm investment income. Irrigation makes an enormous difference to this. Payments in kind to irrigators are not appreciably greater in value than these to dry farmers. Consequently, they play a much smaller part in irrigated farming than in dry farming.

One of the findings is that in some areas full effects of irrigation were not at all apparent at the time of the survey, while in others the stage of development reached might well be termed mature. It has been revealed that there is considerable under-employed population on the fringe of the irrigated tract.

To sum up, no measurable addition is made to land revenue and to the Local Board cess levied on it, on account of irrigation. The increased employment of hired labour is one of the most important indirect effects of irrigation. Generally, the greater employment afforded by irrigation would stabilize the economic position of a considerable number of families in an area, large or small, round the irrigated tract.

An enquiry into the economics of orange orchards, which is the dominant type of fruit cultivation on the Godavari and Pravara Canal systems, covered orchards watered by the *canal* as well as those *watered by wells*. This was done in order to frame a comparative estimate of costs, yields and incomes under the two types of conditions. The income from lucerne is generally a little higher under conditions of canal irrigation because of the heavier watering. Little investment of capital is required for rearing up an orchard under a canal. Under well-irrigation, this investment is, however, substantial. While the well-irrigated orchards created a demand for both (i) permanent and (ii) casual labour, the demand of the canal-irrigated orchards is for the latter only.

In order to arrive at the total direct effect, the first set of statistics necessary are the figure of the total area irrigated by the canals and its distribution under the different crops. In the case of sugarcane, this yield has to be calculated in terms of gur. For both the years 1938-39 and 1939-40, the average yield of gur per acre or crushed sugarcane amounted to 37 Pallas (1 Palla=120 seers) The value of the sugarcane raised and crushed by the factories has been put at Rs. 15/- per ton. The irrigated crops record very substantial increase from sale of sugar-cane and gur.

The table below brings out the difference between the estimated value of gross produce (i) Under Dry and Well-irrigated or purely Dry conditions and (ii) After Canal Irrigation.

			Area Acres	*Total Value of Produce Rs.*
I	Canal irrigated	(Dry)	53,400	1,32,19,775
II	All Dry		86,000	13,37,500
III	Dry and Well irrigated	(Dry)	67,000	49,42,281
		(Well)	13,000	
I	Minus II			1,18,82,275
II	Minus III			82,77,494

It will be seen that the increment of value of gross produce brought about by irrigation is indicated to be Rs. 82,77,494 which may be looked upon as the final measure of the direct effects of the Godavari and Pravara Canal systems. Statements Nos. I, II, and III give respectively (i) Estimated value of Gross Produce after Canal Irrigation (ii) Estimated value of Gross Produce Under Dry and Well-Irrigated or purely Dry Conditions and (iii) Estimates of total Investment and Employment.

The various effects of Irrigation may be summed up as follows :—

(*i*) Direct effects :—Increase of Farm Employment and Farm Produce.

(*ii*) Indirect effects :—Increase of Farm requirements.

(*iii*) Secondary effects :—(*a*) Increase of manufacturing activities, processing activities and transport.

(*b*) Increased demands for goods and services due to increased employment.

The ultimate single yardstick for determination of Government policy purely from a financial angle has generally been the rate of return on an investment. Even to judge benefits from this viewpoint, it does not appear to be sufficient to examine the direct return on public (i.e. State) investment only. The net return to all concerned must be taken cognizance of and booked into account.

Let us consider a typical example given in the report.

Agency	*Capital Expenditure*	*Net return*	*% Return* ×100
	Rs. Lakhs	Rs. Lakhs	
On actual capital outlay			
Government	257	5.9	2·3
Farmers	40	20.0	5·0
Sugar Factories	32	10.0	31·25
Total	329	35.9	10
On total sum at charge			
Arrears of interest on Govt. investment	173	—	—
Grand Total	502	35.9	7.2

The individuals investments by farmers and factories would not have been possible without the public (i.e. State) investment, and hence the public investment is a direct cause of high return on private investment. *It is substantial enough as seen above.* A close examination would show that the State itself (i.e. the Central, Provincial or Local Governments.) reap indirect benefits sufficient to justify the outlay. Thus

Item	*Increased income per annum Rs. Lakhs*
A. Central Government	
Sugar Excise	15.0
Railway Income (Net)	7.9 (O misc)
Income Tax	3.0
Petrol & Miscellaneous import duties	0.58
Posts & Telegraphs	negligible.
Total	26.48

On Rs. 257 lakhs of initial investment, this gives a return of 10.3%.

B. Provincial Government	
Misc. Canal produce	0.125
Land Revenue (Kapargaon Taluka only each year, for 20 years)	0.90
Motor vehicles Registration	0.18
Security of Assessment say.	0.50
Famine expenditure saved say.	0.50
Registration, Stamps	negligible.
Total	1.70

On Rs. 257 lakhs this works out 0.7% return.

C. District Local Boards	Negligible
Grand Total	28.18

It shows that although the direct income on actual capital outlay of Rs. 257 lakhs is only 2.3%, the State Government derived an indirect addition of 0.7% and the Central Government derived 10.3% with very little additional expenditure, if any. There is a larger increase in the volume of trades for manures, implements, livestock etc. and of consumer goods which, in turn, offers again increased opportunities for employment in those trades. Thus, purely, on account of introduction of irrigation, the same land supports a larger population and maintains it in a better condition. The report bristles with a large quantum of data and detailed information on all these heads.

The extent of these effects, direct as well as expansionary, secondary and indirect, is dependent to a very large extent on the nature of crops grown. The vast difference in this respect between sugar-cane, fruit and food grains has actually appeared in the report but it is possible to visualize other types, say,

mass production of fodder. A good deal of vital statistical material strewn all over the pages of the book is available but they are not well marshalled and presented systematically. It would definitely serve its purpose better if the report could be re-edited with suitable chapters and paragraphs to focus the reader's attention chiefly on the quantitative analysis and sum-total of the benefits. The quantitative measurement has no where been summarised. The report brings out prominently that irrigation works, in general, pay sumptuously both to Government and to the irrigators, not withstanding an impression to the contrary, being created by direct revenue from water rates. A more critical study of data in the report will however, show that such results could be expected only when perennial cash crops like sugar-cane, fruits etc. are proportionately stepped up. Water used on cereals alone would bring very little increase in the income of the farmer; in which case heavy items of income to Government like sugar-cane excise and income-tax would not arise and employment of farm-labour and demand for accessories, goods and services would not undergo any great change of expansion in the tract.

The principal conclusion would be that irrigation facilities ought to be created in spite of scanty income from water rates but that perennial and heavy cash crops must also be encouraged if maximum expansion and full use of all resources of a tract are aimed at. It is obvious, as mentioned by Dr. Gadgil, that the lion's share of indirect income and benefits goes to the Central Government but presumably they are certain financial arrangements by which a State Government gets a share of Central Revenues for expenditure within the State. To that extent, any poor return to the State Government, is mitigated.

Statement No. I—Estimated value of Gross Produce after Canal Irrigation

(1 *maund* = 64 *Standard Seers of* 80 *tolas except in case of Groundnut where it is of* 40 *seers.* 1 *palla* = 120 *standard seers.*)

Crop	*Area*† *Acres*	*Produce per acre*	*Total Produce*	*Rate*	*Value of Total Produce Rs.*
Canal-Irrigated					
1. Individual Farmer Sugar-cane	9,500*	37 Pallas	3,51,500 Pallas	Rs. 17 per Palla	59,75,500
2. Factory Plantation Sugar-cane	9,000		2,80,000 Tons	Rs. 15 per ton	42,00,000
3. Fruit Trees :					
(*i*) Mature	1,500			Rs. 850 per acre	12,75,000
(*ii*) Immature	1,000			Rs. 160 ,, ,,	1,60,000
4. Lucerne	2,100			Rs. 312 ,, ,,	6,55,200
5. Jowar Grain Fodder	5,700	8 Maunds	45,600 Maunds,	Rs. 3 per Md.	1,36,800
,, Fodder				Rs. 16 per acre	91,200
6. Wheat	2,500	7½ ,,	18,750 Maunds	Rs. 4.5 per Md.	84,375
7. Fodder	2,000			Rs. 80 per acre	1,60,000
8. Groundnut	2,300	20 ,,	46,000 Maunds.	Rs. 3 per Md.	1,38,000
9. Bajri Grain	2,700	6 ,,	16,200 Maunds	Rs. 4 per Md.	64,800
10. ,, Fodder				Rs. 7 per acre	18,900
11. Gram	3,000	5 ,,	15,000 Maunds	Rs. 4 per Md.	60,00
12. Cotton	2,000	3 Pallas	6,000 Pallas	Rs. 20 per Palla	1,20,000
13. Onions	1,200			Rs. 50 per acre	60,000
14. Miscellaneous	400			Rs. 50 per acre	20,000
TOTAL	53,400‡				132,19,775

† 10,000 acres have been calculated to be under additional fallow and 16,000 acres as waterlogged reducing the total cultivated area of 80,000 acres to 53,400 acres.

* Crushed area only.

‡ Includes 9,500 acres, the standing sugarcane crop area.

Statement No. II—*Estimated value of Gross Produce under Dry and Well-Irrigated or purely Dry conditions*

(1 *maund*=64 *standard seers of* 80 *tolas except in case of groundnut where it is of* 40 *seers.* 1 *palla*=120 *standard seers*).

Crop	*Area Produce Acres*	*per acre*	*Total Produce*	*Rate*	*Value of Total Produce Rs.*
Dry Only					
1. Wheat	25,000	3 Maunds	75,000 Maunds	Rs. 4.5 per Md.	3,37,500
2. Groundnut	15,000	8 ,,	1,20,000 Maunds	Rs. 3 per Md.	3,60,000
3. Gram	10,000	3 ,,	30,000 Maunds	Rs. 4 per Md.	1,20,000
4. Jowar Grain	10,000	3½ ,,	35,000 Maands	Rs. 3 per Md.	1,05,000
,, Fodder				Rs. 8 per acre	80,000
5. Bajri Grain	10,000	2½ ,,	25,000 Maunds	Rs. 4 per Md.	1,00,000
,, Fodder				Rs. 3.5 per acre	35,000
6. Cotton	10,000	1 Palla	10,000 Pallas	Rs. 20 per Palla	2,00,000
TOTAL	80,000				13,37,500
Dry and Well-Irrigated					
(*a*) *Well Irrigated*					
1. Sugarcane	4,000	26 Pallas	1,04,000 Pallas	Rs. 17 per Palla	17,68,000
2. Fruit Trees					
(*a*) Mature	1,600			Rs. 800 per acre	12,80,000
(*b*) Immature	400			Rs. 150 per acre	60,000
3. Lucerne	2,000			Rs. 312 per acre	6,24,000
4. Jowar Grain	2,000	8 Maunds	16,000 Maunds	Rs. 3 per Md.	48,000
,, Fodder				Rs. 16 per acre	32,009
5. Wheat	3,000	7½ ,,	2,250 Maunds	Rs. 4.5 per Md.	10,125
TOTAL	13,000				38,22,125
(*b*) *Dry*	67,000				11,20,156
TOTAL (a) & (b)	80,000				49,42,281

Statement No III—Estimates of Total Investment and Employment

Type of Establishment	*Investment*		*No. of Labourers*	*Wage Bill*	
	Type	*Lakhs of Rs*		*No.*	*Lakhs of Rs.*
I. Individual Farms	Total Permanent	15.0	Farm Servants Total	5,200	7.8
	Additional Permanent	8.0	Farm Servants Additional	4,000	6.4
	Permanent	32.0			
	Working Capital	32.0	Contract and Casual Total		7.8
			Contract and Casual Additional		5.3
II. Factory Plantations	Permanent	31.0	Permanent & Temporary (Containing various elements with different periods of average annual employment)	7,000	11.00
III. Gur Factories :—					
(*i*) Power Driven	Permanent	7.0	Average Period of Employment 21 weeks in a year.	2,500	1.35
(*ii*) Bullock Driven	Permanent	2.0	Average period of Employment 13 to 14 weeks in a year	3,000	1.00

A Major Step Forward

By

A. N. KHOSLA

Vice-Chancellor, University of Roorkee

Being Extracts from the Address delivered at the time of the inauguration of Refresher Courses in the University in November, 1955.

AUTHOR

The first phase of development of the Roorkee Engineering University beyond the undergraduate standard, began with the introduction of two post-graduate courses in 1953-54. The full plan of development for the current Five Year Plan period, as I visualised it, was unfolded by me in my report at the Convocation last year. It envisaged the introduction of more post-graduate courses, of basic and possibly sponsored research, of refresher and specialist courses and of a Water Resources Development Training Centre for Asian and African countries. Four more post-graduate courses have since been started. Eighteen research projects sponsored by the Council of Scientific and Industrial Research, have been undertaken for the first time in the University. Refresher Courses will be starting from today. The Asian-African Training Centre, the last item in the Plan will be inaugurated by our Prime Minister on the 25th of this month.~Except for sponsored research on specific problems on behalf of Governments and Industries, which may take yet a few years more to materialise, the development during the short course of one year has been according to that Plan. The University, from now on, will be catering to the needs of under-graduate and post-graduate training and research and by introducing refresher courses, will be bringing about a union between academic training and practical application so necessary for balanced technological and industrial advance of the country. By opening its portal to engineers from other countries of Asia and Africa, the University will be assuming an international status.

The inauguration of the Refresher Courses today will constitute a major step forward and a most important land mark in the implementation of the plan of development of this University. It will be the beginning of a happy blend of academic training and laboratory research with the application of that training and research to field operations and industry.

The needs for instituting Refresher Courses for serving engineers has been felt for many years. But in view of the fact that engineering activity in pre-independence days, particularly till the end of the second World War, was more or less static and had in fact largely degenerated into routine, this need had never become pressing. In that period there were few new development projects or works under construction. Nevertheless, there was a growing feeling in the engineering profession that the general body of engineers after passing out of colleges got absorbed in routine and that, beoynd the limited requirements of routine and the actual job in hand, they took little interest in new ideas, in improving their engineering knowledge or keeping it upto date. The reason for that attitude was not far to seek. There was almost complete lack of opportunities, nor was there the challenge of new projects which alone could stimulate serious thinking and abnormal effort. After Independence the situation radically changed almost over night. The country became suddenly development concious. A large number of new major development schemes were conceived and old ones raked up. Some of these were urgently taken up for execution. These presented a new challenge to engineers. They had to face new problems and assume new and exacting responsibilities the like of which they had never been called upon to do before. This brought home the importance and urgency of refresher training for all serving engineers.

It is in this background that the University of Roorkee has undertaken to institute refresher courses for serving engineers. These courses will cover all branches of engineering and will be a continuing process. They will at the appropriate stage lead to specialisation bringing thereby an extension of Refresher Courses into Specialist Courses. There is at present a divergence of views among the various engineering departments. Some advocate courses which should give only refresher training so that the engineers after attending these courses would do their normal jobs better than they did before. They suggest specialised courses to be instituted later and for a restricted number. The other group advocates the institution of specialist rather than refresher courses from the very start as they feel it will be waste of time and effort to make every engineer an all-rounder with general refresher training. There is room for both schools of thought. It is proposed later on to run refresher and specialist courses side by side to suit the needs of both these schools.

The original intention was to start refrehser courses in July 1955 but because it involved a major question of policy, requiring number of serving officers to be released for attending these course on duty for a period of 3 months at a time, arranging for their relief, providing a small percentage increase in the engineer-

ing cadres for refresher reserve and making the attendance of refresher courses as a special qualification for promotion, the Governments concerned naturally took time to take decisions. Besides, with the rise in tempo of new construction all over the country, there is a general shortage of technical personnel which is particularly acute in some of the States. For these reasons it has not been possible for all governments to take decisions so far, but a number of them have. We have today 20 engineers from the Centre and the various states of the country who will attend the current course. Some more are likely to join later. Provision is being made for 50 serving engineers attending the refresher courses at a time. It is hoped that by the time the next series of refresher course starts, all Governments will have taken final decisions and that the flow of trainees will be regular, thus enabling the University to make arrangements according to plan and well in advance.

We are grateful to the Central and State Governments for their cooperation in deputing serving engineers for attending the courses as well as providing experts for delivering lectures. We are sure that the step that we are taking today in starting Refresher Courses will pay ample dividends in imparting improved and uptodate knowledge to serving engineers and establishing worthwhile contacts. Both those attending the courses and those delivering lectures will derive benefit. The University teachers will be special gainers by attending lectures of specialists in various fields and by constantly coming in touch with field engineers and field conditions. This gain to the teachers will be an asset to the University and therefore to the nation, as the under-graduates, post-graduates and research workers at the University will have the full benefit of the uptodate theoretical and practical knowledge acquired by the teachers through refresher courses and their contacts with field engineers.

To the serving engineers who have come for attending these courses I extend a most hearly welcome.

REFRESHER COURSES—FIRST SERIES

Programme of Lectures on Water Resources Development & General Engineering

PART I : GENERAL ENGINEERING

	Item No	*Days allotted*	*Dates*
I. General			
1. Introductory remarks about water resources and their bearing on development of the region	1	1	1-11-55
2. General Principles of multiplepurpose basin wide development. Flood control ; Irrigation ; water supply ; road, rail and water communications ; power generation and transmission ; social and economic aspects.	2	1	2-11-55
3. Role of dams in basin wide development and their economics.	3	2	3-4.11.55
II. Surveys & Setection Of Site			
1. Topographical surveys.	1	1	5-11-55
2. Aerial survey (Photogrammetry).	2	2	7- 8-11-55
3. Geological surveys, including geophysical methods.	3-7	3	9-11-11-55
4. Seismic surveys.			
5. Ground Water Surveys.			
6. Foundation exploration.			
7. Survey of stones, aggregates, sands, puzzolana and other construction materials.			
8. Catchment characteristics.	8-13	2	12-14-11-55
9. Soil conservation.			
10. Afforestation.			
11. Silt yield of catchments.			
12. Silting of Reservoirs, silt surveys, density currents.			
13. Silt preventation and control.			
14. Social and Economic Survey.	14	1	15-11-55
III. Hydrology			
1. Precipitation.			
2. Snow surveys.			
3. Rainfall-Runoff relationship and trends in rainfall and runoff.	1-4	3	16-18.11.55
4. Flood intensity, duration and volume ; flood frequency ; flood prediction, qood warnings.			
IV. Selection of Site of Structures			
1. Headworks, major buildings, bridges etc. for consideration of topography, geology, earthquakes, floods storage potential, silting, availability of materials, accessibility, type of structure, etc.	1	1	19-11-55

V.	*Hydraulics*	V	4	21-24-11-55
VI.	*Theory of Structures*	VI	4	25-29-11-55
VII.	*Soil Mechanics*	VII	4	30- 3-12-55
VIII.	*Prestressing Theory and Practice*	VIII	2	5- 6-12-55
IX.	*Concrete and Concrete Materials*	IX	2	7- 8-12-55
X.	*River Training*	X	2	9-10-12-55

Part III : DAMS

Design—Civil Engineering

1. Basic consideration of design of dams on rock and soil foundations, Rolled (earth) fill dams, Rock fill dams, Arch dams, Butress dams, Gravity dams, Composite dams, Other types ; and the suitability of each type for various conditions of topography, seismicity, hydrology, material availability, accessibility etc.	1	2	12-13.12.55
2. Floods, flood routing, spillway studies and spillway capacity.			
3. Modern trends in design of dams and spillways : (*a*) on rock (*b*) on permeable soils.	2	1	14-12-55
4. Design of special features of dams of types listed above e.g. galleries, outlet works penstocks, etc.	3-7	10	15-26-12-55
5. Energy dissipation.			
6. Stability analysis of dams.			
7. Design of blocks and lifts.			
8. Instrumentation in dams.	8	1	27-12-55
9. Evaluation of structural behaviour from instrument observations.	9	1	28-12-55

II. Design—Mechanical Engineering

1. Mechanical Engineering in Dam Design.			
2. High head gates and valves.			
3. Low head gates for barrages.			
4. Spillway crest gates : radial gates, drum gates, slide gates.	1-5	3	29-31-12-55
5. Hoists and cranes.			

III. Design—Hydro-Electrical Engineering

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2. Location and design of power houses.			
3. Design of power plant sub-structure.			
4. Selection of number, size and type of power units and spacing of power units.	4-6	2	4- 5- 1-55
5. General principles of design of turbines.			
6. General principles of design of generators.			
7. Switch yards and transmission lines.	7	2	6- 7- 1-55
8. Electrical systems in dams.			
9. Other electrical equipments in dams, pumps, hoists, etc.	8-9	1	9- 1-56

IV. General

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V. Construction—Civil Engineering

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3. Foundation treatment, Drilling grouting, treatment of faults and weak zones.	10-16, & 18		31- 1-56 at Nangal
4. Materials—Soil materials for earth dams, stones, aggregates, sands, cements, puzzolana, Laboratory tests for strength and soundness. Field Control of earth materials.	4	1	11- 1-56
5. Storage of bulk cement.			
6. Quality Control and testing of concrete on a large dam.			
7. Control of concreting operations.			

(*Continued on page* 28)

Some of the Papers presented to the Atomic Energy Conference held at Geneva

P/ 902 (UN) Guyol ; "World requirements of energy, 1975-2000".
P/ 326 (France), Ailleret : "Estimation of energy requirements".
P/ 757 (UK) Robinson and Daniel : "The world's needs for a new source of energy".
P/ 802 (USA) Mason ; "Energy requirements and economic growth".
(UN) Sevette : Contribution of nuclear energy to future world power needs".
P/ 962 (Yugoslavia) Vukanovic : "Energy and fuel requirements and possibilities of the FPR Yugoslavia".
P/ 987 (Australia) Commonwealth Department of National Development : "Electric power in Australia—1955-2004".
P/ 949 (Belgium) Van Mele : "Probable evolution of energy needs in Belgium and the possible role of nuclear energy."
P/ 799 (Czechoslovakia) Sevcik : "Prospects of power development in Czechoslovakia and the part to be played by nuclear energy for peaceful pruposes".
P/1060 (Japan) : "Japan's energy utilization, the present and the future".
P/ 998 (Argentina) Mendivelzua : "Energy needs and and resources of the Argentina Republic".
P/ 868 (India) Bhabha : "The need for power in India during the next 30 years and the possibilities of the economic use of atomic power".

The Building of a Nuclear Energy Enterprise

P/ 615 (USSR) Nikolayev : "The first atomic power station in the USSR and the prospects of atomic power production".
P/ 851 (USA) Zinn et al : "Design and operating experience of a prototype boiling water power resctor."
P/ 391 (UK) Hill and Joslin : "Capital investment required for nuclear energy".
P/ 477 (USA) Davis : "Capital investment required for nuclear energy".

Factors in the use of Nuclear Energy

P/ 476 (USA) Lane : "Economics of nuclear power".
P/ 390 (UK) Jukes : "The cost of power and the value of plutonium from early nuclear power stations".
P/ 867 (UK) Dunworth : "Possible role of thorium in nuclear energy".

The Role of Nuclear Power in the next 50 years

P/ 893 (UN) de Breuvery and Barnea : "Some economic implications of nuclear power for underdeveloped countries".
P/ 11 (Canada) Davis and Lewis : "An economic forecast of the role of nuclear power in Canada".
P/ 327 (France) Ailleret and Taranger : "Integration of nuclear energy among the means of energy production".
P/ 758 (UK) Kay : "The role of nuclear energy in relation to other methods of electricity generation".
P/ 954 (Norway) Lundby : "Reciprocal atomic and hydro-electric power generation".
P/1002 (Argentina) Iraolagoitia : Role of atomic energy in the Argentina Republic".
P/ 475 (USA) Mayer : "A study of the economic potential of nuclear energy".
P/ 389 (UK) Cockcroft : "The contribution of nuclear power to United Kingdom energy requirements up to 1975".

International Co-operation in the Peaceful Uses of Atomic Energy

P/ 619 (USSR) Lavrishchev : "Assistance of the Soviet Union to other countres in the peaceful application of atomic energy".
P/ 805 (USA) Libby : "International co-operation in atomic energy developments".

Education and Training of Personnel in Nuclear Energy

P/ 983 (UNESCO) : "Training of research staff in the field of peaceful uses of atomic energy".

Fuel Cycles

P/ 4 (Canada) Lewis : "Some economic aspects of nuclear fuel cycles".
P/ 403 (UK) Dunworth and Fenning: "Fuel Cycles".
P/ 862 (USA) Weinberg : "Fuel cycles and reactor types".

Design of Reactors for Power Production

P/ 333 (France) Chambadal and Pascal ; "Utilization of energy released in the graphite-moderated air-cooled pile G_1".
P/ 337 (France) Ailleret et al : "Design of the dual purpose pile G_2".
P/ 492 (USA) Carson : "A graphite-moderated nuclear power plant design".
P/ 493 (USA) Starr : "A sodium graphite reactor 75,000 electrical kilowatt power plant".
P/ 936 (Netherlands) Went et al : "A 'wet' suspension of uranium oxide for a homogeneous power reactor".
P/ 938 (Netherlands) Bruyn et al : "A 'dry' suspension of uranium oxide for a heterogeneous power reactor".
P/ 494 (USA) Miles and Williams: "Liquid metal fuel reactor".
P/ 335 (France) Weill : 'Complete automatic control of nuclear reactors".
P/ 405 (UK) Kendall and Fry : "The Dounreay fast reactor project".
P/ 814 (USA) Zinn : "Review of fast power reactors".
P/ 495 (USA) Iskenderian et al : "Boiling water reactor for industrial power".
P/ 624 (USSR) Alichanow et al : "Homogeneous power-producing water boiler".
P/ 496 (USA) Briggs and Swartout : "Aqueous homogeneous power reactors".

(*Continued on page* 29)

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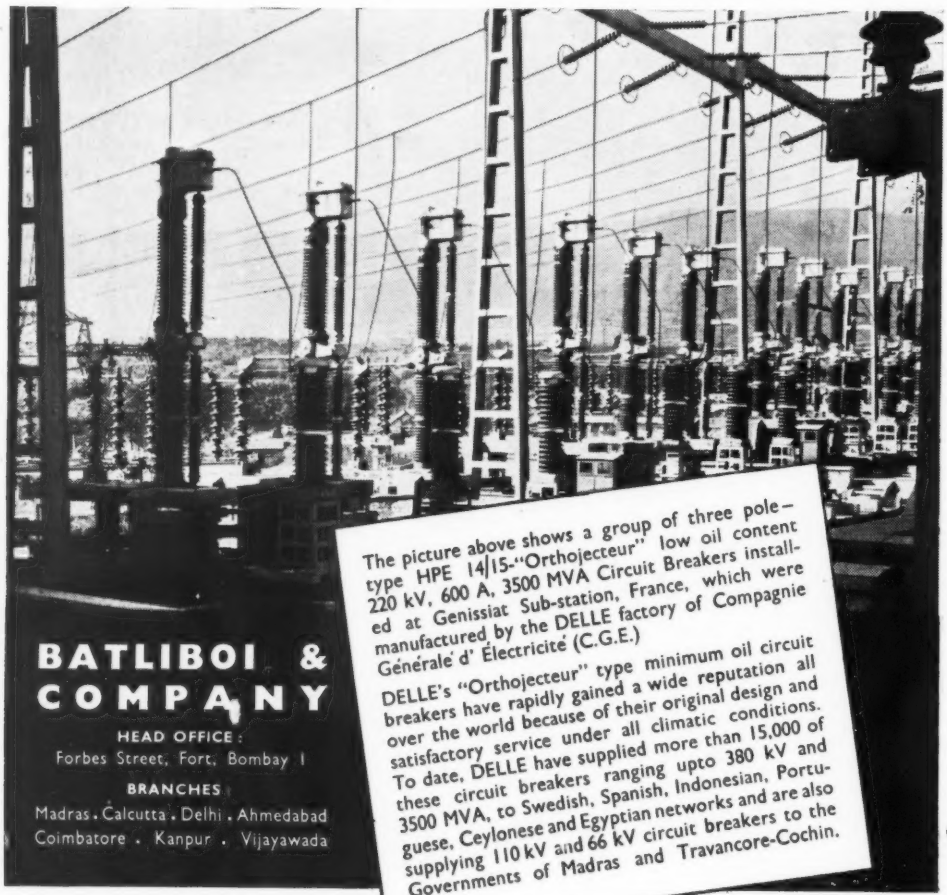

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SISTA'S B-49

Our Delhi Letter

(From our own correspondent)

The River Valley Projects under construction received great attention from India's eminent guests from Russia. Both Mr. Bulganin and Mr. Khrushchev made Bhakra Nangal Project almost the first place of their visit. The Project authorities gave them a big welcome and men and women of the entire campus at Nangal and Bhakra met these dignitaries during various inspections and other functions at the site of the Dam. People came in vary large numbers from neighbouring villages to hear of the great progress that has been made in Russia. The assurances of mutual assistance in the technical field evinced great admiration from the gatherings. In particular, the conversation that took place between Mr. Khruschev and General Manager Khungar and Construction Director Slocum found wide publicity in the Indian Press.

Need for Economy in Steel

Mr. Khruschev displayed keen observation while being conducted around the work and particularly enquired about the part which Indian Officers were playing in assuming the full responsibility for the design and construction of the Dam. He remarked that India was short of steel and it behoved Indian Engineers to ensure that as little of this material should be used as possible by adopting alternative construction techniques using reinforced concrete or pre-stressed concrete ("tensioned concrete"). The same remarks were made by Mr. Khruschev later when he was visiting the Integral Coach Factory at Bangalore. In both instances Mr. Khruschev was assured by the Officers incharge that the design using all steel construction was the most economical and enabled quickest construction. This however, did not satisfy Mr. Khruschev and he is reported to have said that the Engineers in his own country told him "the same story" which left him sceptical, and he eventually had succeeded in inducing them to use less steel by alternative methods of design and construction.

There is a lesson to be learnt from these instances as India is now going to be short of steel till her new steel factories come into being. The reason for the predominant use of steel in our structures is the fact that British practice taught us only this alternative for the last half-a-century. Reinforced concrete came into the field in India in the late twenties and sufficient know-how and experience does not yet exist in the country to use this form of construction with confidence and economy. The biggest snag is in the matter of shuttering which becomes such an expensive item due to dearness of materials, whether they be timber or steel. Also our construction largely uses hand labour methods which are more suitable for brick work rather than mass concrete. But it is clear that the engineers and architects of the country have been aroused to the necessity of reviewing their design procedure in a constructive spirit to effect economies in steel.

Board of Consultants meeting at Bhakra Dam

The Bhakra dam Design and construction problems came under the review of the special Board of Consultants of which a meeting was convened early in December at Nangal. This Board has on its panel Shri A. N. Khosla, Shri Kanwar Sain, Messrs. Banks (Grand Coulee), B. W. Steele (Army Corpsof Engineers), Mr. Hammond (Originally from U.S.B.R.), Dr. Nickell, Consulting Geologist and Mr. Crosby, Consulting Geologist. General Manager, Shri Khungar, Mr. Slocum and other officers of the Bhakra Dam Designs and Construction Organizations also participated in the deliberations of the Board. Shri V. P. Sondhi, Director, Geological Survey of India was present by invitation. It is learnt that the Board was impressed with the progress already made in the planning, designing and construction of this stupendous job. One constructive suggestion approved in the deliberations of the Board was the acceptance of the use of Pozzolanic material in the mass concrete of the dam. This pozzolana will be produced at the site by the calcination of shale of which large deposits exist within one thousand feet of the dam site. The results obtained at the Project laboratories in respect of the qualities of this pozzolana are said to be entirely satisfactory. The Project authorities are busy exploring methods for the setting up of a calcination plant coupled with a pulverising plant. The pozzolana to be manufactured will have a fineness much greater than cement and its use is calculated to lead to an economy in cost and the quantity or cement. Besides, an improvement in the quality of concrete is also confidently expected due to the extra workability and impermeability that will be imparted to the mass concrete. It is hoped that about 150,000 tons of this material will be produced in the course of 4 years during the entire concreting period of most of the work in the dam proper, powerplants and appurtenant works. About one year ago, the use of pozzolana was considered by a special panel of the Institution of Standards, India, in their sectional meeting that was held at Calcutta. It is gratifying to note that the recommendations of that committee have been endorsed by the Bhakra Project authorities under advice of the Board of Consultants. This opens a new chapter in the history of use of pozzolana in Indian Projects.

More & still more Power needed in the country

With the increasing tempo of works on the river valley projects and with the introduction of industrialisation in the Second Five Year Plan, the need is expected to arise of many more projects having to be taken up in the near future. In the case of the Hirakud and D.V.C. and Bhakra projects, it is now confidently expected that the entire power generated from these projects will be utilized in the industries already set up or expected to be set up shortly within the regions connected with these projects. The physical load surveys which were previously accepted in justification of restriction of generation are now found to be quite inadequate in the face of the growing demand in these regions. The arguments previously given that use of electric power is beyond the pocket of both the small consumer and the big consumer are now being

reversed. These potential consumers are convinced that the only way of increasing their earnings and standards of living is through new industries of the cottage, village and heavy type. The Planning Commission and Ministries incharge of Irrigation and Power, and Commerce and Industry have all acknowledged the necessity for expanding the scope and programmes of power generation. The Finance Departments of the Government of India and the various States have also arrived at the conclusion that it would be a short-sighted policy, if additional investments are not made promptly on creative projects, as these alone bring an end to the era of poverty in India.

Detailed Planning of future Projects

This situation had led to a great insistence on planning of further projects which should supplement those already undertaken. Any vagueness in a project is now considered a serious handicap and the Planning Commission has desired that sufficient details must be worked out to enable a fairly accurate forecast to be prepared for any Project which has to be taken up seriously. This factor has thrown a new challenge to planners and leaders in the engineering profession.

Water Resources Development Training Centre

The University of Roorkee was the scene of a historic development towards the end of November when the Prime Minister, Shri Jawahar Lal Nehru, performed the inauguration ceremony of the Water Resources Development Centre for Asia and Africa in the University premises. He hoped that the institution would develop into an instrument of real service for Asia and Africa and the experience that has been evolved in India in a century of irrigation history will be made available for the good of these two continents. The Prime Minister laid stress on quality in the work of designing and construction of large river valley projects and said that no compromise could at all be made in this respect due to any considerations of narrow nationalism. "We must have the very first rate men to do these important jobs", he said, "and if any considerations of nationalism were allowed to interfere in the excellence of such schemes, we must regard such nationalism as second rate".

Need for Central Pool of Engineering Personnel

Since the shortage of personnel with suitable qualifications and experience to tackle such jobs is well recognized, the only solution which can be efficacious for advancing the development of the country is to create a central pool of selected personnel, who can implement the ambitious programmes of the States and the Centre. Such a pool of Engineers has to be formed out of the pick of officers from Government departments as well as engineers of repute from private enterprise. This is, no doubt, a big step and involves a lot of administrative difficulties. The scales of pay which are offered to such personnel have also to be made commensurate with their market value. There is however, no short cut to such a desideratum and the steel frame of departmental rules or other handicaps which have so far throttled progress has to be made flexible or done away with in a sufficient degree to enable constructive action. The Engineers' Seminars as well as the Central Ministry of Irrigation and Power have wished for such a step for the last 3 years but no tangible results are visible on the horizon. On many a platform, including the Institution of Engineers, the Central Board of Irriga-

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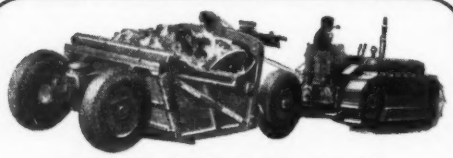

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(*Continued on page* 30)

Economic Development and Political Boundaries

Redemarcation of boundaries of the States in India has been a live, almost an explosive, issue for sometime. A high-power Commission was appointed sometime ago and after a period of strenuous labours on its part it has submitted its Report popularly known as the S.R.C. Report. This has set in motion a vast country wide discussion and controversy and occasionally the passions have been running high. The debates in the Legislative Assemblies of the States and in the Parliament have just concluded and time has now come to arrive at firm decisions.

Political boundaries cannot be ends in themselves. Apart from other considerations, rapid economic development of a backward region like India, which has been stagnating economically for several centuries in the past, must be one of the prime criteria of judgement. It is necessary to view the issue of boundaries of States from this point of view.

Prime Minister Nehru's memorable speeches in the Lok Sabha and the Rajya Sabha on this subject should enable many to make their attitudes a little more flexible and long-ranged. Our past experience even with regard to the execution of river valley projects confirms the viewpoint that political boundaries cutting across a river system come in the way of efficient execution of these projects which occupy such an important place in the national Plan. Tungabhadra, Damodar Valley, Bhakra-Nangal, Mata Tila projects could have been started earlier and more efficiently executed if these were not to deal with inter-State relationships.

Based on linguistic considerations, some of the States will be smaller in size than should be. Thus the problem of inter-state relationships in river valley projects in the future will increase numerically. And given the generated passion and distrust between adjacent States, the chances of a smooth and harmonious working of joint inter-state bodies would become more difficult. It, therefore, now appears that redemarcation of States on primarily linguistic considerations would not be very conducive to rapid economic development.

Sri. Nehru has now come round to the view that larger States would be better units for purposes of economic development than a large number of smaller ones. But it appears that it is too late for that. He has therefore proposed the idea of Zonal Councils of a number of adjacent States—five Zones for the whole country—"regardless of language". These Councils would "consider mutual economic, developmental and border problems". They will be advisory in character. The main idea behind the scheme is "to develop the habit of cooperative working."

The Zonal Scheme, though still in a vague form, has been hailed by many, mainly because they saw in it the only ray of hope of unity in an otherwise surcharged atmosphere of tension and disturst among the peoples of the country. Possibly an agreed framework for these Zonal Councils may be evolved and set in constitutional motion. But has it intrinsic worth? Has it an inherent internal strength to bind together different States and peoples *conscious of their separateness?*

To us it appears that due to this unfortunate controversy the "emotional integration of India" has received a serious set back and, in the words of Sri. Nehru, "we have gone too far in the contrary direction." The linguistic principle of demarcation has not worked out well.

The only other alternative principle that has come to our notice is briefly as follows :

"The other important idea that needs consideration is that in carving out provinces in the country the *basic and major principle should be the natural resource-base*. After all the major task of the State in our poverty-stricken country is economic. Rapid economic development is the primary task of the administration. Other considerations are secondary. A scientific development of the natural resources is possible only on the basis of river basin-wise planning. India is a land of rivers. Major river basins, coupled with such adjustments as the Deccan pleateau and the range of Power Grids should be the basic foundation of provinces. (Minor adjustments may be allowed on linguistic grounds). Once this is done, provincial administration will coincide with natural economic regional units, and this will greatly facilitate rapid economic development. If this happens, much of the bitterness and conflict among communities in the country would subside with growing opportunities, income and employment to the people." (*From a Memorandum to the S.R.C., April* 1954)

It is interesting to note that as early as 1941 Mr. M. W. M. Yeats, Census Commissioner for India had discussed the idea of delimitation on the basis of river basins in his *Introduction to the Census of India.* The advantages arising from such a demarcation are well argued there and need not the repeated.

If rapid economic development of the country is to remain a prime consideration, it is worthwhile to give due weight to the above point of view.

But in case the country is constituted of States which do not harmoise with the river basins, an alternative *modus vivendi* for promoting economic development may be the one suggested by us in our Memorandum to the D.V.C. Enquiry Committee as early as January 1953, from which the following extract is taken :

"It is our understanding that rapid resource development is the major economic task before the country. This can be most efficiently accomplished only if each of the major river basins is developed as a single integral unit on the pattern of the T.V.A.

The organisational method to perform the task would be to establish autonomous project authorities for each of these basins. The Estimates Committee happily appears to approach the problem similarly. The activities of these regional authorities would then need to be co-ordinated by the Central Government. The co-ordinating body, possibly the Planning Commission, would thus be transformed into a centre of a vast 'economic grid' as it were. The Government of India as well as those of the States are actively pursuing numerous investigations on the basis of river basins. Sooner or later these will be ripe for actual execution. It is, therefore, necessary to plan in advance the suitable organisational structure in outline, so that as and when the plans are ready the necessary project authorities may be set up without great difficulty or delay. It is of course needless to to state that in each specific case there is bound to be room for regional diversity or for adjusting to specific problems. Such a method of resource development would and should hold true whether the project area covers one state or more than one. (See "India and the T.V.A. Method", editorial, *Indian Journal of Power & River Valley Development*, D.V.C. Special Number, Vol. II, No. 2, 1952)."

Whatever may be the institutional form of co-operation for economic betterment, it would work only where there is *the will to cooperate*, which is a mental act on the part of individuals and peoples. The tragedy is that this will itself is weakening at a rapid pace. Therefore, while giving due consideration to the forms and symbols of cooperation, the task of the moment is to arrest the corrosion of this will and to strengthen it by informed and intelligent education.

LETTER TO THE EDITOR

DEAR SIR,

I invite your attention to the article "Power Development in India" in your magazine Vol. IV No. 6 & 7 (CW & PC Special) written by Sri. M. Hayath, member (Hydro-electric) of Central Water & Power Commission. In the above article under the heading "Progress in States" on page 39 mention is made regarding survey work on the 66 k.V. transmission lines under the Tungabhadra project and it is also mentioned that the ownership of the main works under the project is vested in Mysore State. In this connection I have to inform that the ownership of the project does not vest in the Mysore State and that it vests in the Tungabhadra Board and that Andhra State bears the greater share of the cost of the electrical works viz. 80%. I request that necessary correction slip may be issued.

Kurnool — L. VENKATAKRISHNA AYYAR,
Dt. 16-12-54 — *Special Chief Engineer for Irrigation*

(*Continued from page* 22)

A Major Step Forward

8. Batching and mixing of concrete for a large dam.			
9. Concrete and materials laboratory.	9	1	12- 1-56
10. Air entrainment in concrete and air entraining agents.			
11. Quality Control in masonry dams.			
12. Pressure grouting.			
13. Construction Planning.			
14. Organisation for construction.			
15. Layout for a large concrete dam, masonry dam, diversion dam.			
16. Construction of tunnels ; blasting excavation, muck hauling ; pumcrete, lining of tunnels, grouting, tunnel excavation under pressure.			
17. Construction of Coffer dams.	17	2	13-14- 1-56
18. Hydraulic sluicing.			
VI. Construction-Mechanical Engineering			
1. Construction machinery : Earth moving compaction, rock excavation, drilling, pumping, aggregate plant, concrete plant for processing, mixing and placing, conveyors, etc.			
2. Operation and maintenance and overhaul of construction machinery			
3. Design and erection of construction plant for large dams.	1-to 5		At Nangalr 16/1 to 31-1-1956
4. Belt conveyance, aerial ropeways, classification plant, cooling plant, cement handling plant, batching and mixing plant, trestles, double cantilevers and revolving cranes, cable ways.			
5. Materials, fabrication, erection and maintenance and operation of gates, hoists, pumps, penstocks etc.			
VII. Hydraulic Lab and Fluid Research			
1. Role of experiments in design and maintenance of works	1	2	2- 3- 2-56
VIII. Erection & Maintenannce Electrical Engineeringx			
1. Transport, erection and maintenance of Water Turbine and Alternators.	1	4	4/2-8/2-56
2. Erection & Maintenance of Swtichgear L.T. and H.T.	to 4		
3. Erection & Maintenance of Transformers and Transmission lines.			
4. Protection of Electrical Equipment & metering.			

Book Review

Search for Purpose by A. E. MORGAN, *published by The Antioch Press, Yellow Springs, Ohio, U.S.A., pp* 197 *price* : $ 3.00.

The author is already well known in this country as the first Chairmn of the TVA and as a reputed civil engineer consultant. But it is significant that he is also known in his country as a bold social thinker and educationist. He was a member of the University Commission in India of which Dr. Radhakrishnan was the Chairman. Thus the range of his interests is indeed wide and whatever subject he has dealt with it was with a great deal of acute insight. He is the author of over a dozen books dealing on such varied subjects as Philosophy, Education, Soil Conservation and Community Welfare. Most of them are off the beaten track and thought-provoking.

This book, as the name suggests, is more comprehensive and compels attention, for it deals with some basic and yet perennial issues that crop up in the minds of every thoughtful and sensitive individual. Every man needs an over-all attitude to life as a guide during his lifetime. Although autobiographical in style in some parts, the book raises problems of the future of man as a species in the biological and the natural world. Dr. Morgan applies the modern method and spirit of science in all the manifold problems of cosmology and ethics and attempts to evolve a general attidude and outlook on life for himself. But he never for one moment tries to develop a *closed* system, for the pursuit of knowledge is not yet over and final attitudes are therefore not permissible. But he indicates how with the present degree of knowledge it is possible to choose the most probable and plausible attitudes as guides to life, both in the physical and the social world.

Man being a part of nature, of the biological world, Dr. Morgan has always kept this basic fact in mind and this basic relation of man with nature colours his outlook throughout the book. Yet, he has recognised the special abilities in man which has been further cultivated and developed by his own efforts. Thus his attitude to man is more optimistic than usual. He stands for an attitude of increasing mastery over nature on the part of man, and points out in an interesting way the role of introspective and speculative philosophy in keeping India materially backward for several centuris. He says :

"The mastery of the objective world is on a par, in importance, significance and value, with the mental and spiritual development of men. The two elements of development are necessary to each other, and neither can go very far without help of the other". (p. 105).

He remarks that while India neglected in the mastery of nature by preoccupation with introspection, America is going to the other extreme and is neglecting self-mastery and clarification of purpose.

Dr. Morgan has given a lot of thought to the problem of population and eugenics and his proposals are striking though not popular.

Another basic social issue that he has discussed is that of competition and cooperation. He did not consider them as mutually exclusive. Rather he considers that cooperation is necessary today in order to promote the biologically vital element of competition and better and intelligent selection.

On the whole the book is extremely stimulating and should be widely read throughout the world with the purpose of formulating ones' own attitude to life. We specially recommend it to all engineers.

K.K.S.

The Fundamental Principles of Irrigation Engineering by V. B. PRIYANI, published by Charotar Book Stall, Station Road, Anand. Pp. 384 price Rs. 15.

This is the second edition of the book which was very well received in the engineering colleges and universities in its first edition. In the words of Sri M. Visvesvaraya, the book is concise and written in clearly intelligible language. The numerous drawings and sketches are very appropriate.

In this second edition the additional features include : a chapter on River Training, a chapter on Preparation of Irrigation Projects and 29 photographs of scale models of Irrigation structures. These certainly enhance the value of the publication.

We unreservedly recommend it to the students in engineering.

(*Continued from page* 23)

Some of the Papers presented to the Atomic Energy Conference held at Geneva

Power Reactors, Prototypes

P/ 815 (USA) Simpson et al : "Description of the pressurized water reactor (PWR) power plant".
P/ 879 (NORWAY) Dahl : "Preliminary study of an experimental pressurized heavy water reactor".
P/ 497 (USA) Harrer et al : "The engineering design of a prototype boiling water reactor power plant".
P/ 498 (USA) Beall and Swartout : "The homogeneous reactor test".
P/ 499 (USA) Parkins : "The sodium reactor experiment".
P/ 406 (UK) Hinton : "The graphite-moderated gas-cooled pile and its place in power production".
P/ 501 (USA) Barnes et al : "The engineering design of a prototype fast neutron reactor power plant".
P/ 813 (USA) Cerrutti : "Operating experience and experimental results obtained from a Nak cooled fast reactor".

Occurrence of Uranium and Thorium

— (UN) Kerr : Survey paper "The natural occurrence of uranium and thorium".
P/ 470 (USA) Johnson : "Nuclear fuel for the world power program".
P/ 127
P/ 129} (Brazil) de Morais : Discussion on Uranium and Thorium Occurrences.

P/ 328 (France) Roubalt : ,,
P/ 471 (USA) Nininger or Everhart :
P/ 759
P/ 760 (UK) Davidson : ,,
P/ 761
P/ 875 (India) Wadia ,,
P/ 918 (Italy) Ippolito : ,,
P/ 968 (Portugal) Cavaca : ,,
P/ 999 (Argentina) Angelelli : ,,
P/1036 (Japan) ,,
P/1071 (Austrialia) (Canada) Lang : ,,

(*Continued from page 26*)

Mr. Nehru proceeding to the Bhakra Dam Site to inaugurate the concreting of the Dam.

tion and Power, and other departmental congregations, the maxim is accepted as self-evident, but somehow there is not enough pursuance of the mattre in higher quarters and the wishes remain as pious sentiments rather than a constructive schedule for implementing an urgent proposal.

Design & Research

In particular, the centralization of research and design appears paramount. At present we have various research organizations in the States and the Centre, but the co-ordination of results is unable to keep pace with the requirements. It is however an obvious fact that findings of research which lie unutilized and untested in the annals of various institutes do not represent any advance, till these are passed through the crucible of actual tests, first in the design and then in the construction stage. River Valley Projects of the future are going to involve more and more difficulties and new problems and a revolutionary approach appears highly called for if results are to be achieved.

National Institutes of Technology

On the question of personnel, the procedures being followed in the Institute of Technology at Kharagpur are being mentioned in knowledgable circles as particularly progressive and worthy of emulation. The proposed Technological Institude in the State of Bombay is sure to have vast prospects for augmenting the numbers of progressive engineers. What is most urgently needed is that the very brightest candidates should be attracted to the engineering profession by offering them attractive conditions of initial employment and subsequent service from the very start. Shri Kanwar Sain has, in his various talks on his visits to Russia and China, mentioned how in these countries the engineering graduates are earmarked for various organizations and firms even before they leave College. The same procedure should apply to graduates in our engineering colleges and they should be absorbed in the particular branches of engineering which are best suited to their aptitude and academic stature. Just as the I.A.S. and I.P.S. are constituted on an all-India basis, the Indian Service of Irrigation and Power Engineers should be revived. This recommendation has now found acceptance even in the report of States Reorganization Commission and its implementation appears highly called for if we are to develop the resources of this country according to the targets of the second Five Year Plan.

Rubble Stone Concrete

The Central Board of Irrigation while discussing the concrete versus masonry symposium in its last Board meeting took cognizance of a rubble stone-concrete specification in which rubble stone of large size is proposed to be dumped in cement mortar upto a content of 40% in the construction of dam. This specification is clearly attractive for places where aggregate and gravel are not readily available and rubble stone of a proper quality is readily available. It is understood that in the specifications being prepared for the Koyna Project, it is intended to use rubble stone concrete in certain portions of the dam. This innovation will have a very important future and it behoves all progressive engineers to give their attention to its study in the laboratory as well as in the field. It will, in fact, be a befitting end of the controversy that has arisen in the country about concrete versus masonry. This form of construction will, in fact, be concrete-cum-masonry.

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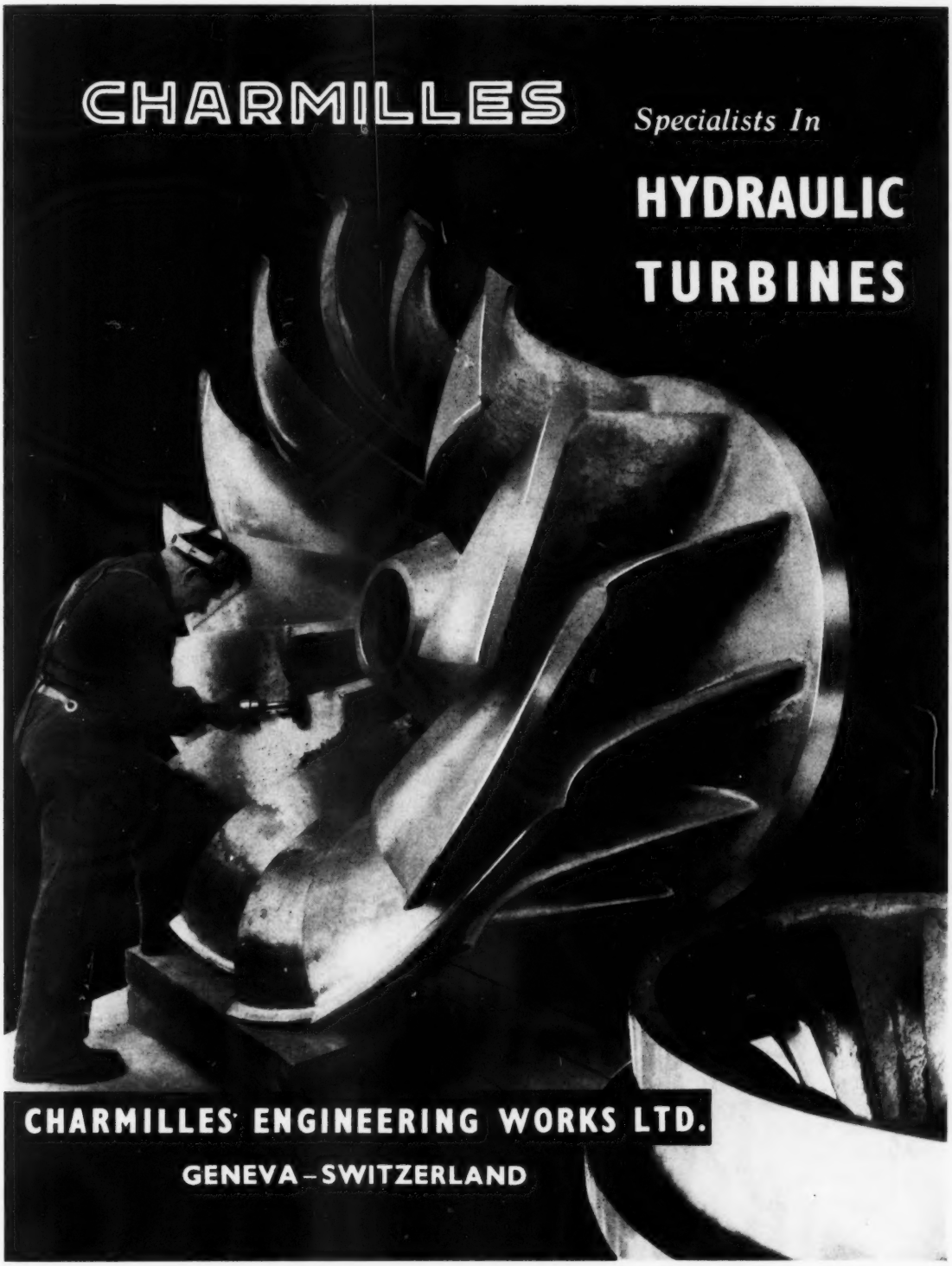

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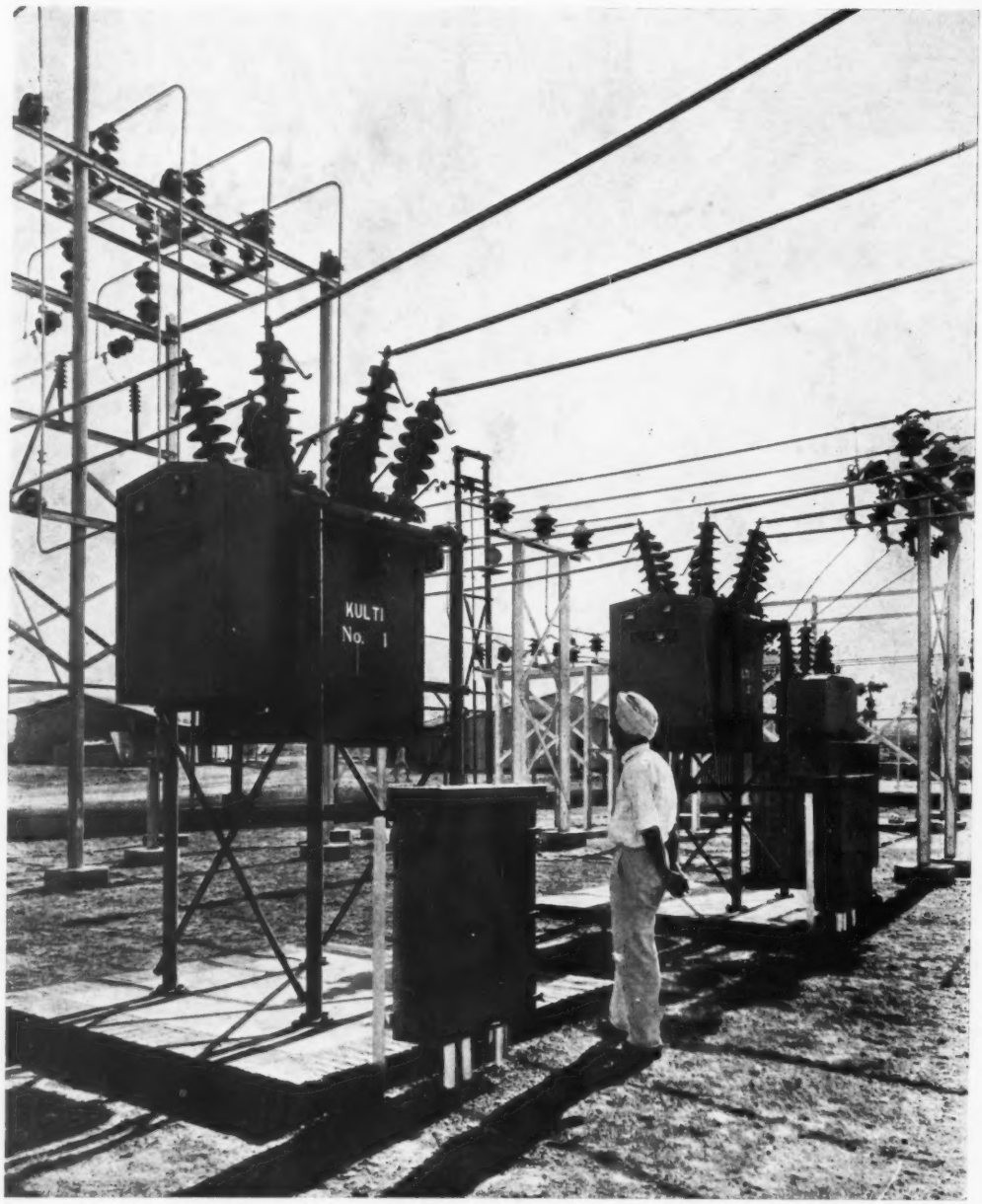

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